Monticello Mill Tailings Site

Operable Unit III Remedial Investigation/ Feasibility Study Work Plan

Volume II

Draft Final

September 1995

U.S. Department of Energy
Grand Junction Projects Office

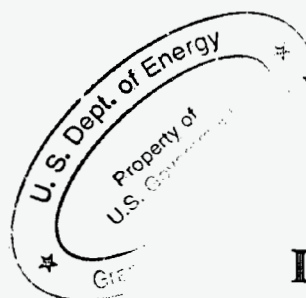# Monticello Mill Tailing Site Operable Unit III

Remedial Investigation/Feasibility Study

Work Plan

Volume II

Draft Final

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Prepared for
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Preliminary Evaluation of
Potentially Applicable or Relevant and Appropriate Requirements

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A1.0 Introduction

Potentially applicable or relevant and appropriate requirements (ARARs) for Operable Unit (OU) III remedial activities at the Monticello Mill Tailings Site (MMTS) focus on Federal and State environmental laws. ARARs are identified on a site-specific basis. The selection of an ARAR depends on specific chemicals at the site, site characteristics, and particular actions anticipated as remedies. Section A2.0 of this appendix addresses potential Federal ARARs and Section A3.0 addresses potential State of Utah ARARs. Each section is organized according to the three types of ARARs (chemical-specific, location-specific, and action-specific).

A2.0 Potential Federal ARARs

A Federal Facility Agreement between the U.S. Environmental Protection Agency (EPA) Region VIII, the State of Utah Department of Health, and the U.S. Department of Energy (DOE) was implemented in December 1988 for the MMTS. In November 1989, MMTS was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List.

The purpose of the Federal Facility Agreement was to ensure that environmental impacts associated with past and present activities at the millsite and on peripheral and vicinity properties are thoroughly investigated and that the appropriate response action is taken and completed as necessary to protect public health and the environment. According to the MMTS Federal Facility Agreement, legally applicable or relevant and appropriate requirements may include

1. The Atomic Energy Act, as amended.

2. The Uranium Mill Tailings Radiation Control Act of 1978, as amended.

3. The Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, 40 Code of Federal Regulations (CFR) 192.

4. The National Environmental Policy Act of 1969, as amended; the Council on Environmental Quality Regulations, 40 CFR 1500; and DOE Guidelines (45 Federal Register [FR] 53199, 45 FR 78756, 47 FR 7976).

5. DOE Orders 5480.1A ("Environmental Protection, Safety and Health Protection Program for DOE Operations"); 5480.4 ("Environmental Protection Standards, Safety and Health Protection Standards"); and 5440.1C ("Implementation of the National Environmental Policy Act").

6. "Formerly Utilized Sites Remedial Action Program-Summary Protocol" (January 1986), as amended; and "Surplus Facilities Management Program Plan" (October 1, 1985), as amended.

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7. Federal Water Pollution Control Act, as amended by the Clean Water Act Amendments of 1986.

8. The Safe Drinking Water Act, as amended.

9. The National Historic Preservation Act of 1966, as amended.

10. The Archaeological and Historical Resources Protection Act of 1979.

The ROD for OU I and OU II (DOE-GJPO 1990) listed DOE Orders as "To Be Considered." A list of potentially applicable or relevant and appropriate Federal requirements for OU III is presented in Table 1. It is understood that the authorization process for allowing a State to implement a Federal program is generally a phased-process. Because of this, the State of Utah may not have adopted a specific rule or portion of a regulatory program. In such instances, if a non-adopted rule or regulation in a State implemented program is a potential ARAR, the Federal standards will apply.

A2.1 Potential Federal Chemical-Specific ARARs

Chemical-specific ARARs set health- or risk-based concentration limits for particular hazardous substances or contaminants in air, soil, water, etc. The principal contaminants of concern at OU III are radioactive and nonradioactive substances associated with uranium and vanadium mill tailings. Monitoring has indicated that concentrations of uranium, vanadium, molybdenum, selenium, and arsenic in some ground-water wells on the site exceed values observed for these constituents in upgradient wells. Other contaminants include direct-gamma radiation, radon, and Ra-226. The contaminants of concern can have either carcinogenic or toxic effects in humans (for more information see the Toxicity Assessment and Public Health Evaluation in Section 8.0 of the Remedial Investigation [UNC Geotech 1990]). The contaminant exposure pathways considered are direct exposure, inhalation, and ingestion.

A2.1.1 Safe Drinking Water Act

The regulations for implementing the Safe Drinking Water Act (SDWA), as amended, contain criteria and procedures to ensure a supply of drinking water that dependably complies with maximum contaminant levels. They include quality control and testing procedures that ensure proper operation and maintenance of a potable public water supply system; specify the minimum quality of water that may be taken into the system; and provide siting requirements for new facilities for public water systems. Additionally, the SDWA addresses the Underground Injection Control Program.

The SDWA National Primary and Secondary Drinking Water Regulations at 40 CFR 141 and 143 are considered in this analysis as potentially relevant and appropriate chemical-specific requirements for OU III because of the presence of the Burro Canyon Formation which is located at depth beneath the millsite and which is used as a public water supply. Should contamination associated with millsite activities be identified in the Burro Canyon aquifer,

maximum contaminant levels may be used to established cleanup standards. However, because the standards are enforced by the State of Utah through the Federally approved program under the SDWA (see discussion at Section A3.1, Utah Division of Drinking Water), these SDWA requirements are not potential Federal ARARs.

The provisions of the SDWA at 40 CFR 144, the Underground Injection Control Program, are considered in this analysis as potentially applicable chemical-specific (and action-specific) requirements in the event that ground water is injected into the aquifer during OU III remediation. However, because the standards are implemented by the State of Utah through the Federally approved program under the SDWA (see discussions at Section A3.1, Utah Division of Water Quality), these SDWA requirements are not potential Federal ARARs.

A2.1.2 Federal Water Pollution Control Act, as Amended by the Clean Water Act of 1977

Water Quality Criteria--The water quality criteria of the Clean Water Act (CWA) and the regulations at 40 CFR 131 are considered potentially applicable chemical-specific requirements to OU III because of the importance of ensuring that the surface waters of Montezuma Creek are protected. The CWA provides criteria for states to set water quality-standards on the basis of toxicity to aquatic organisms and human health. Evidence exists that the surface water in Montezuma Creek is contaminated. However, because the standards are enforced by the State of Utah through the Federally approved program under the CWA (see discussion at Section A3.1, Utah Division of Water Quality), the CWA water-quality criteria are not potential Federal ARARs.

National Pollution Discharge Elimination System (NPDES)--The discharge of pollutants into waterways is regulated and permitted under the NPDES program, as specified at 40 CFR 122 through 125. Depending on the ground-water treatment technology option selected for OU III, a point-source effluent discharge into Montezuma Creek may be used. Thus, the NPDES chemical-specific (and action-specific) Federal standards are identified as being potentially applicable for OU III. However, because these standards are enforced by the State of Utah through the Federally approved program under the CWA (see discussion at Section A3.1, Utah Division of Water Quality) the NPDES requirements are not potential Federal ARARs.

A2.1.3 Clean Air Act

The purpose of this act is to protect and enhance the quality of the nation's air resources so as to promote public health and welfare and the productive capacity of the nation's population. A provision of the act is that the prevention and control of air pollution at its source is the primary responsibility of state and local governments.

Regulations at 40 CFR 50, the National Primary and Secondary Ambient Air Quality Standards (NAAQA) establish standards for ambient air quality which protect the public welfare from any known or anticipated adverse effects of a pollutant. Regulations at 40 CFR 61, National Emission Standards for Hazardous Air Pollutants (NESHAPs) establish standards

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for new stationary sources. These chemical-specific (and action-specific) standards are potentially applicable as point-source air emission control limits for construction and operation of treatment facilities. Because these requirements are implemented through the Federally approved air quality program in the State of Utah, they are not considered potential Federal ARARs (see discussion at Section A3.1, Utah Division of Air Quality).

A2.1.4 Resource Conservation and Recovery Act

The provisions for implementing this act are found at 40 CFR Parts 260 through 280. Resource Conservation and Recovery Act (RCRA) requirements for treatment, storage, or disposal of hazardous waste apply to a Superfund site (1) if the site contains RCRA-listed or RCRA-characteristic hazardous waste that was treated or disposed of after the effective date of the RCRA regulations that are under consideration as potential ARARs for the site or (2) if the CERCLA activity at the site constitutes current treatment, storage, or disposal of RCRA hazardous waste. There is an exclusion for source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011 et seq., at 40 CFR 261.4(a)(4).

Characterization of the MMTS and historical information indicates that no RCRA-listed or RCRA-characteristic hazardous wastes were treated or disposed of at the site. No treatment, storage, or disposal of a RCRA hazardous waste is taking place or is anticipated to take place at the millsite. Furthermore, Extraction Procedure Toxicity tests performed on millsite tailings at uranium mill tailing remediation action sites indicate that uranium mill tailings similar to those at Monticello, Utah, are not hazardous wastes as defined by RCRA. However, methanol, a hazardous waste, may be generated during remedial investigation activities (i.e., ground-water sampling). Therefore, RCRA may be a potentially applicable chemical-specific requirement. However, because hazardous waste management standards are implemented through the Federally approved program in the State of Utah, they are not potential Federal ARARs (see discussion at Section A3.1, Utah Division of Hazardous Waste).

A2.1.5 Uranium Mill Tailing Radiation Control Act of 1978

The regulations promulgated at 40 CFR Part 192, including those regulations in 60 FR 2854 that replace 40 CFR 192.20(a)(2) and (3), are not applicable because the site does not meet the statutory or jurisdictional prerequisites that are applicable only to 24 inactive uranium mill and tailings sites. However, the regulations are potentially relevant and appropriate because:

- The intent of Congress was to relate these standards to inactive uranium mill tailings sites, and the Monticello site is an inactive uranium mill tailings site. It is the gross alpha and metal content of uranium processing wastes that are regulated by these standards.

- The regulations were promulgated to control tailings that were dispersed into the environment and pose a threat to human health and the environment. Dispersion of contaminants into the environment through ground- and surface-water pathways has occurred.

- The numeric standards for health and environmental cleanup are potentially relevant and appropriate for corrective action. The Uranium Mill Tailing Radiation Control Act (UMTRCA) Ground-Water Standards for MRAP OU III are presented in Table A-2.

A2.2 Potential Federal Location-Specific ARARs

Location-specific ARARs establish additional requirements on the basis of unique characteristics of a site that could be affected as a result of remedial action. Location-specific ARARs may be used to restrict or preclude certain activities or remedial actions on the basis of location or characteristics of a site.

A2.2.1 Federal Water Pollution Control Act, as Amended by the Clean Water Act of 1977

Dredge or Fill Requirements (Section 404)—The provisions of 40 CFR 230 and 231 and 33 CFR 323 require permits for the discharge of dredged or fill material into navigable waters. Although permits are not required for on-site activities at Superfund sites, the intent of these requirements must be met for any potential remedial activity which would impact site wetlands. Therefore, this Federal location-specific (and action-specific) provision is found to be potentially applicable.

A2.2.2 National Historic Preservation Act of 1966, as amended

The regulations implementing this act at 40 CFR 6.301(b) require Federal agencies to take into account the effect of any Federally assisted undertaking or licensing on a structure or object that is included on or eligible for the National Register of Historic Places. These regulations are considered to be potentially applicable location-specific requirements for OU III remedial activities.

A2.2.3 Archaeological and Historical Preservation Act of 1979

This act establishes procedures to provide for the preservation of historical and archaeological resources that may be destroyed through alteration of terrain as a result of a Federal construction project or a Federally licensed activity or program. On the basis of recent archaeological surveys, the Federal regulations are considered potentially applicable location-specific requirements for remedial activities associated with OU III.

A2.2.4 Fish and Wildlife Coordination Act

This act requires consultation with the U.S. Fish and Wildlife Service whenever a Federal department or agency proposes or authorizes modification of any stream or other water body and requires adequate provisions for the protection of fish and wildlife resources. The

Montezuma Creek channel may be modified during remediation of OU III. Recent flora and fauna surveys identified no fish but showed that there may be temporary short-term loss of habitat for wildlife. This requirement is a potentially applicable location-specific Federal ARAR.

A2.2.5 Endangered Species Act

This act requires that Federal agencies ensure that any action authorized, funded, or carried out by such agencies is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat required for the continued existence of that species. Although no presently threatened or endangered species have been identified at or near the MMTS, these location-specific Federal provisions are potentially applicable requirements.

A2.2.6 Bald and Golden Eagle Protection Act

This act provides for the preservation of the bald and golden eagle through the protection of the individual raptor and its prodigy. This act, which is administered through the U.S. Fish and Wildlife Service, prohibits the taking, possessing, selling, purchasing, transporting, exporting or importing of any eagle part, whether alive or dead, or any part, nest, or egg thereof. The term "take," as defined in the statute, includes pursue, shoot, shoot at, poison, kill, capture, trap, collect, molest or disturb. Protection of an eagle habitat may be included in the term disturb. As stated in the *Final Remedial Investigation/Feasibility Study-Environmental Assessment for the Monticello, Utah, Uranium Mill Tailings Site* (UNC Geotech 1990), neither bald or golden eagles occur at or near the MMTS; however, they could occur in the area. In this instance, the use of the MMTS as a habitat is considered remote due to a lack of arboreal vegetation. Because the possibility exists that these eagles could be present in this area, or that the MMTS could become an eagle habitat, these Federal standards should be considered as potentially applicable location-specific requirements for OU III activities.

A2.2.7 Executive Orders 11988 - ("Floodplain Management") and 11990 - ("Protection of Wetlands")

These Presidential orders require Federal agencies to evaluate actions they may take so as to avoid, to the maximum extent possible, adverse impacts associated with direct and indirect development of a floodplain/wetlands. 10 CFR 1022 was issued to implement the requirements of Executive Orders 11988 and 11990. Remediation of OU III may potentially impact site floodplains or wetlands. Therefore, these orders are potentially applicable as location-specific ARARs.

A2.2.8 Floodplain/Wetlands Environmental Review Requirements

These requirements are found at 10 CFR 1022 and establish policy and procedures for discharging the Department of Energy's responsibilities with respect to compliance with Executive Order 11988, "Floodplain Management." They have been considered throughout

the compliance process, as is evidenced by the *Federal Register Notices*, Notice of Floodplain Involvement, and opportunity for public comment of May 2, 1986, for the MMTS. These Federal standards should be considered potentially applicable location-specific requirements for OU III activities.

A2.2.9 Farmland Protection Policy Act

This act, which is administered through the U.S. Soil Conservation Service, addresses adverse effects of a Federal agency's actions on significant and important agricultural lands. Because agricultural lands are located adjacent to the MMTS, any remedial actions associated with OU III should be evaluated in terms of potential adverse effects on these farmlands. This act is considered a potentially applicable location-specific requirement.

A2.3 Potential Federal Action-Specific ARARs

Action-specific ARARs are performance, design, and other requirements that control remedial activities or actions. These requirements are not concerned with contaminants present or with site characteristics/location but address how a selected remedial action alternative must be achieved. Action-specific requirements may specify particular performance levels, actions, or technologies, as well as specific levels (or a methodology for setting specific levels) for discharged or residual contaminants.

It should be noted that during the present scoping stage for the OU III Remedial Investigation/Feasibility Study, only potential chemical- and location-specific ARARS need be identified. Action-specific ARARs are generally identified for each proposed alternative during remedial alternative development in the Feasibility Study. However, in an attempt to expedite ARAR identification, action-specific potential ARARs are included in this report.

A2.3.1 Uranium Mill Tailing Radiation Control Act of 1978

UMTRCA is the primary action-specific ARAR pertaining to the development of a ground water remedial action plan for the Monticello Millsite. In accordance with EPA's recent promulgation of Final Ground Water Standards for Remedial Actions at Inactive Uranium Processing Sites (60 FR 2854, effective 2/10/95), the remedial action plan must: specify how applicable clean-up standards would be satisfied; include a schedule with the steps necessary to achieve ground water remediation at the site; document the extent, type, rate and direction of movement, and assess future plume movement; and, specify details of the method to be used for clean-up of ground water. Additionally, UMTRCA and its associated regulations at 40 CFR 192 provide the means for implementing Alternate Concentration Limits (clean-up standards other than those provided in Table A-2) for ground water remediation. Thus, this Federal act is considered a potentially relevant and appropriate action-specific (and chemical-specific) requirement for OU III activities.

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A2.3.2 Safe Drinking Water Act

The provisions of the SDWA at 40 CFR 144, the Underground Injection Control Program, are considered in this analysis as potentially applicable action-specific (and chemical-specific) requirements in the event that ground water is injected into the aquifer during OU III remediation. However, because the standards are implemented by the State of Utah through the Federally approved program under the SDWA (see discussions at Section A3.3, Utah Division of Water Quality), these SDWA requirements are not potential Federal ARARs.

A2.3.3 Federal Water Pollution Control Act, as Amended by the Clean Water Act of 1977

National Pollution Discharge Elimination System (NPDES)—The discharge of pollutants into waterways is regulated and permitted under the NPDES program, as specified at 40 CFR 122 through 125. Depending on the ground-water treatment technology option selected for OU III, a point-source effluent discharge into Montezuma Creek may be used. Thus, the NPDES action-specific (and chemical-specific) Federal standards are identified as being potentially applicable for the OU III. However, because these standards are enforced by the State of Utah through the Federally approved program under the CWA (see discussion at Section A3.2, Utah Division of Water Quality), the NPDES requirements are not potential Federal ARARs.

Dredge or Fill Requirements (Section 404)—The provisions of 40 CFR 230 and 231 and 33 CFR 323 require permits for the discharge of dredged or fill material into navigable waters. Although permits are not required for on-site activities at Superfund sites, the intent of these requirements must be met for any potential remedial activity which would impact site wetlands. Therefore, this Federal action-specific (and location-specific) provision is found to be potentially applicable.

A2.3.4 Clean Air Act

NAAQA regulations at 40 CFR 50, establish standards for ambient air quality which protect the public welfare from any known or anticipated adverse effects of a pollutant. NESHAP regulations at 40 CFR 61, establish standards for new stationary sources. These action-specific (and chemical-specific) standards are potentially applicable as point-source air emission control limits for construction and operation of treatment facilities. Because these requirements are implemented through the Federally approved air quality program in the State of Utah, they are not considered potential Federal ARARs (see discussion at Section A3.3, Utah Division of Air Quality).

A2.3.5 National Environmental Policy Act (NEPA) of 1969, as amended

The provisions of this act are considered potentially applicable to all removals, including any ground- or surface-water contamination source removal. Additional guidance that would be considered under NEPA includes the Council on Environmental Quality Regulations, 40 CFR 1500; DOE Guidelines (45 FR 20694, 45 FR 53199, 45 FR 78756, 47 FR 7976); and DOE

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Order 5440.1C (*Implementation of NEPA*), and *Secretarial Policy Statement on the National Environmental Policy Act* (issued June, 1994).

A3.0 Potential State ARARs

Because the MMTS is located in southeastern Utah, compliance with all State of Utah-specific environmental rules, regulations, standards, criteria, or limitations that are applicable or relevant and appropriate to OU III is mandatory. A list of potential Utah ARARs for OU III is presented in Table A-3.

A3.1 Potential State Chemical-Specific ARARs

A3.1.1 Utah Division of Drinking Water

Drinking Water Rules—These rules represent the State's implemented version of the Federal Safe Drinking Water Act's National Primary and Secondary Drinking Water Regulations. As discussed in Section A2.1, the Utah-implemented program is considered a potentially relevant and appropriate chemical-specific requirement.

A3.1.2 Utah Division of Water Quality

This is the State-implemented version of the Federal Clean Water Act program.

Water Pollution Rules—The definitions for water pollution and the general requirements are potentially applicable chemical-specific requirements.

Standards for Quality for Water of the State—These rules are specific to Utah waters and are potentially applicable chemical-specific requirements.

Utah Pollution Discharge Elimination System—As discussed in Section A2.1, these rules are potentially applicable chemical-specific (and action-specific) requirements for effluent discharge associated with an aquifer remediation system.

Ground-Water Protection—Utah-specific ground-water protection standards are addressed by this rule. An equivalent Federal program does not exist. These ground-water rules are potentially applicable chemical-specific (and action-specific) requirements.

Underground Injection Control Program—As discussed in Section A2.1, these rules are potentially applicable chemical-specific (and action-specific) requirements for the use of Class V Remediation Wells if aquifer injection is included in the selected remedial design package.

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A3.1.3 Utah Hazardous Waste Management Rules

As discussed in Section A2.1, these rules are potentially applicable State of Utah chemical-specific requirements in the event that methanol, a hazardous waste, is generated during remedial investigation activities (i.e., ground-water sampling).

A3.1.4 Utah Division of Air Quality

Utah Air Conservation Rules—As discussed in Section A2.1, these rules are potentially applicable State of Utah chemical-specific (and action-specific) requirements for controlling point-source air emissions from construction and new stationary source operation treatment facilities. These are part of the State-implemented version of the Federal NAAQA and NESHAPs programs.

A3.1.5 Utah Division of Radiation Control

The general provisions and definitions of these State of Utah rules are potentially applicable chemical-specific requirements for the management of radioactive materials. The licensing requirements for handling radioactive materials also contain some substantive standards for transporting radioactive materials. These rules are potentially applicable chemical-specific requirements.

A3.2 Potential State Location-Specific ARARs

The Utah Division of State History have requirements that address the protection of archaeological, anthropological, and paleontological resources on State lands and/or associated with projects conducted or approved by State agencies. This requirement is identified as a potentially applicable location-specific requirement.

A3.3 Potential State Action-Specific ARARs

A3.3.1 Utah Division of Water Quality

Utah Pollution Discharge Elimination System—As discussed in Section A2.3, these rules are potentially applicable action-specific (and chemical-specific) requirements for effluent discharge associated with an aquifer remediation system.

Ground-Water Protection—Utah-specific ground-water protection standards are addressed by this rule. An equivalent Federal program does not exist. These ground-water rules are potentially applicable action-specific (and chemical-specific) requirements for remediation of OU III.

Underground Injection Control Program—As discussed in Section A2.3, these rules are potentially applicable action-specific (and chemical-specific) requirements for the use of Class V Remediation Wells if aquifer injection is included in the selected remedial design package.

A3.3.2 Utah Division of Air Quality

Utah Air Conservation Rules—As discussed in Section A2.3, these rules are potentially applicable State of Utah action-specific (and chemical-specific) requirements for controlling point-source air emissions from construction and new stationary source operation treatment facilities. These are part of the Utah-implemented version of the Federal NAAQA and NESHAPs programs.

A3.3.3 State of Utah Division of Water Rights

These requirements include well drilling and abandonment standards. This law is a potentially applicable action-specific State of Utah requirement for all OU III-associated well drilling and abandonment activities.

A4.0 References

DOE-GJPO, 1990, *Monticello Mill Tailings Site Declaration for the Record of Decision and Record of Decision Summary*, DOE/ID/12584-50, U.S. Department of Energy, Grand Junction Projects Office, Grand Junction, Colorado.

UNC Geotech, 1990, *Final Remedial Investigation/Feasibility Study-Environmental Assessment for the Monticello, Utah, Uranium Mill Tailings Site, Volumes I and II*, DOE/EA-0424, U.S. Department of Energy, Grand Junction Projects Office, Grand Junction, Colorado.

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Table A-1. Federal Potentially Applicable or Relevant and Appropriate Requirements for Operable Unit III

Standard, Requirement, Criteria, or Limitation	Citation	Description	Status	Comment
Safe Drinking Water Act National Primary Drinking Water Standards	42 USC 300(g) 40 CFR 141	Establishes health-based standards for public water systems (maximum contaminant levels).	Potentially relevant and appropriate through the State of Utah Standards as a chemical-specific requirement.	The Burro Canyon Formation is used as a water-supply aquifer. MCLs may apply as clean-up standards.
National Secondary Drinking Water Standards	40 CFR 143	Establishes welfare-based standards for public water systems (secondary maximum containment levels).	Potentially relevant and appropriate through the State of Utah Standards as a chemical-specific requirement.	The potential for communication between the contaminated shallow alluvial aquifer and a water- supply aquifer (Burro Canyon) exists.
Clean Water Act Water Quality Criteria	33 USC 1251-1376 40 CFR 131 Quality Criteria for Water, 1986	Criteria for states to set water quality standards on the basis of toxicity to aquatic organisms and human health.	Potentially applicable through the State of Utah Standards as a chemical-specific and action-specific requirement.	Addresses Montezuma Creek contamination.
National Pollution Discharge Elimination System	40 CFR 122 through 125	Requires permits and establishes standards for discharges of pollutants into waterways.	Potentially applicable through the State of Utah Standards as a chemical-specific and action-specific requirement.	A point source effluent discharge into Montezuma Creek may be utilized dependent upon the selected ground-water remediation technology.
Dredge or Fill Requirements (Section 404)	40 CFR 230 and 231 33 CFR 323	Requires permits for discharge of dredged or fill material into navigable waters.	Potentially applicable as a location-specific and action-specific requirements.	Discharge of dredged or fill material into navigable waters or wetlands may occur during remedial action.
Clean Air Act National Primary and Secondary Ambient Air Quality Standards	42 USC 7401-7462 40 CFR 50	Establishes standards for ambient air quality to protect public health and welfare.	Potentially applicable through the State of Utah Standards as a chemical-specific and action-specific requirement.	Federal standards are applicable, but are implemented through the air program of the State of Utah.
Resource Conservation and Recovery Act (RCRA)	42 USC 6901 40 CFR 260-280	RCRA requirements for treatment, storage, or disposal of hazardous waste apply to a Superfund site if the site contains RCRA listed or characteristic hazardous waste that was treated or disposed of after the effective date of the RCRA regulations that are under consideration as potential ARARs for the site, or if the CERCLA activity at the site constitutes current generation, treatment, storage, or disposal of RCRA hazardous waste.	Potentially applicable through the State of Utah Standards as a chemical-specific requirement.	Hazardous waste (i.e., methanol) during remedial investigation activities (i.e., ground-water sampling).

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Standard, Requirement, Criteria, or Limitation	Citation	Description	Status	Comment
Uranium Mill Tailings Radiation Control Act, Part 192	42 USC 2022, 42 USC 7901-7942	Establishes health-based ground-water remediation standards for inactive uranium processing sites.	Potentially an action-specific and chemical-specific requirement.	Although the clean-up standards apply only to certain specifically designated sites where uranium was processed, they are potentially relevant and appropriate because uranium and vanadium were processed at this site, and it is the gross alpha and metals content of uranium processing wastes that are regulated by these standards. The ground-water standards are presented in Table C-2.
National Historic Preservation Act	16 USC 470 40 CFR 6.301(b)	Requires federal agencies to take into account the effect of any federally assisted undertaking or licensing on a structure or object that is included on or eligible for the National Register of Historic Places.	Potentially applicable as a location-specific requirement.	Applies to any district, site, building, structure, or object listed on or eligible for the National Register.
Archeological and Historic Preservation Act	16 USC 469 40 CFR 6.301(c)	Establishes procedures to provide for preservation of historical and archeological data which might be destroyed through alternation of terrain as a result of a Federal construction project or a Federally licensed activity or program.	Potentially applicable as a location-specific requirement	Applies if the remedial or disposal alternatives affect historical or archeological sites.
Fish and Wildlife Coordination Act	16 USC 661-666 40 CFR 6.302(g)	Requires consultation when a Federal department or agency proposes or authorizes any modification of any stream or other water body; requires adequate provisions for protection of fish and wildlife resources.	Potentially application as a location-specific requirement.	The Montezuma Creek channel may be modified during remediation, which may result in habitat loss for fish and wildlife species.

Standard, Requirement, Criteria, or Limitation	Citation	Description	Status	Comment
Endangered Species Act	16 USC 1531-1543 50 CFR 17 & 402 40 CFR 6.302(h)	Requires that Federal agencies ensure that any action authorized, funded, or carried out by such agencies is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat.	Potentially applicable as a location-specific requirement.	Currently threatened or endangered species or critical habitat are not present on the site.
National Environmental Policy Act	40 CFR 1500	Requires that all Federally undertaken actions be assessed for potential environmental impacts. All potential environmental impacts must be properly mitigated.	Potentially applicable as an action-specific requirement.	Applicable for contamination source removal activities.
Floodplain/Wetlands Environmental Review	40 CFR 6, Appendix M	Establishes agency policy and guidance for carrying out the provisions of Executive Orders 11988 "Floodplain Management" and 11990 "Protection of Wetlands."	Potentially applicable as a location-specific requirement	Potential ground- and surface-water remediation actions could potentially impact site floodplains and/or wetlands.
Farmland Protection Policy Act	7 USC 4201 7 CFR 658	Standards and criteria for identifying and taking into account adverse effects of an agency's actions on significant and important agricultural lands.	Potentially applicable as a location-specific requirement.	Administered through the US Soil Conservation Service. may be applicable if significant and important agricultural land is impacted.

Table A-2. Uranium Mill Tailings Radiation Control Act of 1978; Ground-Water Standards for Operable Unit III[a]

Maximum Concentration of Constituents for Ground-Water Protection	
Chemical Constituent	Maximum Concentration (mg/L)
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.002
Molybdenum[b]	0.1
Selenium	0.01
Silver	0.05
Nitrate (as N)[b]	10
Endrin (1,2,3,4,10,10-hexachloro-1,7-epoxy-1,4,4a,5,6,7,8, 9a-octahydro-1, 4-endo, endo-5,8-dimethano naphthalene)	0.0002
Lindane (1,2,3,4,5,6-hexachlorocyclohexane, gamma isomer)	0.004
Methoxychlor (1,1,1,-Trichloro-2, 2-bis, p-methoxyphenylethane)	0.1
Toxaphene ($C_{10}H_{10}Cl_6$, Technical chlorinated camphene, 67-69 percent chlorine)	0.005
2,4-D (2,4-Dichlorophenoxyacetic acid)	0.1
2,4,5-TP Silvex (2,4,5-Trichlorophenoxypropionic acid)	0.01
Radioactive Constituent	pCi/L
Combined radium-226 and radium-228[b]	5
Combined uranium 234 and uranium 238[b]	30
Gross alpha-particle activity (excluding radon and uranium)[b]	15

[a]40 CFR 192; Revised 7/1/86.
[b]60 FR 2854; effective 2/10/95

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Department/Division	Subject	Statute	Rule	Comments
Division of Water Rights	Well drilling standards (standards for drilling and abandonment of wells)	73-3-25, U.C.A.	R655-4, U.A.C.	Includes such requirements as performance standards for casing joints, and requirements for abandoning a well. This law is potentially applicable to all drilling anticipated for any of the alternatives. Potentially applicable action-specific requirement.
Division of State History	Protection of archaeological, anthropological resources.	63-18-18, U.C.A.	R224, U.A.C.	Section 63-18-18, U.C.A.,states legislative interest and paleontological in preservation of archaeological, anthropological and paleontological resources. Section 63-18-25, U.C.A., addresses historical resources on state lands, and Section 63-18-37, U.C.A. addresses projects by state agencies. Potentially applicable location-specific requirement.
Department of Environmental Quality, Division of Water Pollution Control	Definitions for Water Pollution Rules and General Requirements	Title 19, Chapter 5, U.C.A.	R317-1, U.A.C	Potentially applicable chemical-specific requirement.
	Standards for Quality for Waters of the State	Title 19, Chapter 5, U.C.A.	R317-2, U.A.C	These rules are specific to Utah waters, though they are derived in part by using Federal criteria. See particularly the nondegradation policy in R448-2-3. Potentially applicable chemical-specific requirement.
	Ground-Water Protection	Title 19, Chapter 5, U.C.A	R317-8, U.A.C	The Division of Water Pollution Control, in cooperation with other Divisions in the Department, promulgated ground-water protection standards. There is no corresponding Federal program. Potentially applicable chemical-specific and action-specific requirement.
	Utah Pollution Discharge Elimination System	Title 19, Chapter 5, U.C.A	R317-8, U.A.C.	A point-source effluent discharge into Montezuma Creek may be utilized dependent upon the selected ground-water remediation technology. Potentially applicable chemical-specific and action-specific requirement.
Department of Environmental Quality, Division of Drinking Water	Safe Drinking Water Rules	Title 19, Chapter 11, U.C.A.		This is the State of Utah implemented Safe Drinking Water Act program. Maximum contaminant levels may apply as potentially relevant and appropriate chemical-specific requirements.

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Department/Division	Subject	Statute	Rule	Comments
Department of Environmental Quality, Division of Air Quality	Utah Air Conservation Rules	Title 19, Chapter 2, U.C.A.	R307-1, U.A.C	These rules are substantively identical to corresponding Federal regulations, with the following exceptions: (1) R446-1-1.25 and R446-1-3.1.8, which require application of best available control technology for any source; (2) R446-1-3.11, which lists criteria to be considered in establishing visibility standards; (3) R446-1-4.1, which sets visible emission standards; (4) R446-1-4.5, which regulates fugitive dust emissions; and (5) R446-1-5.1, which allows the State to require temporary closure of air pollution sources in the event of an air pollution emergency episode. These rules are potentially applicable chemical-specific and action-specific requirements for controlling point-source air emissions from construction and operation treatment facilities. This is the State of Utah-implemented National Primary and Secondary Ambient Air Quality Standards program.
Department of Environmental Quality, Division of Radiation Control	General provisions and definitions for management of radioactive materials.	Title 19, Chapter 3, U.C.A.	R447-12, U.A.C.	Potentially applicable chemical-specific requirement.
	Licensing requirements for handling radioactive materials.	Title 19, Chapter 3, U.C.A.	R447-19, 21 and 22, U.A.C.	Although these provisions relate primarily to licensing requirements, they also contain some substantive standards. Example: R447-19-500 states standards for transportation of radioactive materials. These standards are potentially applicable chemical-specific requirements.
Department of Environmental Quality, Division of Hazardous Waste	Hazardous Waste Management Rules		R315, U.A.C	These rules are potentially applicable chemical-specific requirements; hazardous waste (i.e., methanol) may be generated during remedial investigation activities (i.e., ground water sampling).

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Monticello Operable Unit III RI/FS Work Plan

Previous Investigation Data

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Figure B-1. Sediment Sampling Location Map for 1982 Characterization

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% FREQUENCY

Prevailing winds are illustrated based on the direction from which the wind is blowing.

Figure B-2. Rose Diagram of Prevailing Annual Wind Trends for the Millsite WeatherStation Data, 1982 through 1989
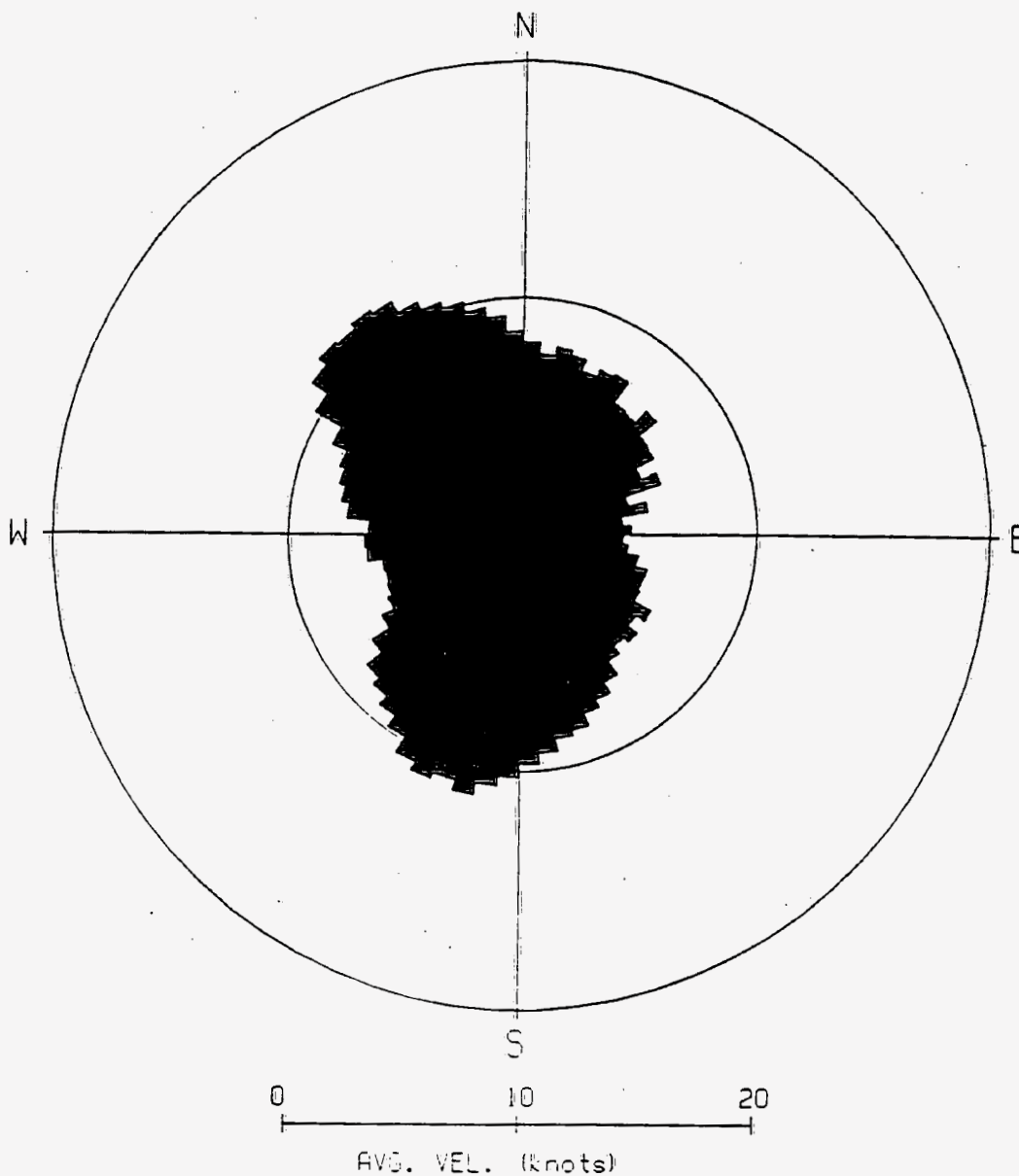
Average magnitudes are illustrated based on the direction from which the wind is blowing.

Figure B-3. Rose Diagram of Annual Average Wind Magnitudes for the Millsite Weather Station Data, 1982 through 1989

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Table B-1. Upper and Lower Montezuma Canyon 1982 Investigation Data

Sample Location[a]	As (ppm)	Mo (ppm)	Se (ppm)	U (ppm)	V (ppm)	Ra-226[b] (pCi/g)
S1	5	4	<5	11	100	7.1
	7	2	<5	4	85	5.5
	4	2	<5	9	95	11.0
S2	6	10	<5	66	185	10.4
S3	5	4	<5	9	75	6.1
	7	4	<5	8	130	11.0
	4	2	<5	11	115	6.2
S4	5	4	<5	24	110	5.3
	5	4	<5	15	155	24.6
	4	4	<5	23	200	36.7
S5	4	4	<5	6	65	11.0
	5	6	<5	21	150	9.1
	5	4	<5	12	95	12.0
S6	3	2	<5	1	60	1.2
	3	2	<5	1	60	2.0
	3	2	<5	1	65	1.9
S7	6	2	<5	4	65	2.8
	3	2	<5	10	70	NA[c]
	4	2	<5	2	50	NA
S8	5	2	<5	<1	35	2.3
	4	2	<5	<1	25	NA
	6	2	<5	<1	35	1.9

[a]Three individual samples were collected at each sample location. Sample S2 is an exception where one composite sample was collected.
[b]Ra-226 activities were derived from gamma spectroscopy analysis of the individual soil samples.
[c]NA = Results not available.

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Table B-1. Upper and Lower Montezuma Canyon 1982 Radiological Investigation Data (continued)

Sample Location[a]	As (ppm)	Mo (ppm)	Se (ppm)	U (ppm)	V (ppm)	Ra-226[b] (pCi/g)
S9	3	2	<5	<1	25	NA
	3	2	<5	1	30	3.5
	4	4	<5	<1	30	1.9
S10	4	7	<5	1	85	0.4
	4	7	<5	<1	70	NA
	6	4	<5	1	65	1.0
S11	5	7	<5	12	115	10.9
	5	4	<5	17	150	10.8
	5	4	<5	35	320	54.3
S12	3	4	<5	12	125	14.2
	4	4	<5	11	95	9.1
	5	7	<5	23	190	25.1
S13	4	4	<5	10	105	4.4
	3	4	<5	15	95	4.9
	4	4	<5	11	90	4.9
S14	5	7	<5	14	115	4.6
	5	7	<5	13	120	7.8
	7	7	<5	15	175	2.5
S15	4	4	<5	8	100	4.0
	4	4	<5	8	95	4.1
	5	4	<5	7	90	5.7

[a]Three individual samples were collected at each sample location. Sample S2 is an exception where one composite sample was collected.
[b]Ra-226 activities were derived from gamma spectroscopy analysis of the individual soil samples.
[c]NA = Results not available.

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Table B-2. Upper and Lower Montezuma Canyon - 1984 and 1987
Radiological Investigation Data

Location Number	Grid Coordinates		Measurement Type*	Ra-226 Concentration (pCi/g)	Depth (inches)	Comments
	Northing	Easting				
1	9424	25403	DS	4.8	00	
			DS	4.1	06	
			SS	5.0	00-06	
2	9542	25403	DS	16.2	00	
			DS	9.9	06	
			SS	19.0	00-06	
			DS	5.5	12	
			SS	13.0	06-12	
3	9642	25403	DS	5.4	00	
			SS	3.0	00-06	
4	9764	25403	DS	5.7	00	
			DS	3.2	06	
5	9964	25403	DS	5.9	00	
			SS	5.0	00-06	
			DS	4.2	06	
6*	9304	25603	DS	4.6	00	
			DS	5.2	06	
			SS	6.0	00-06	
7*	9344	25603	DS	1.7	00	
			SS	2.0	00-06	
8*	9764	25603	DS	14.3	00	
			DS	11.4	06	
			SS	34.0	00-06	
			SS	23.0	06-12	
			DS	3.5	12	
9	9252	25803	DS	4.0	00	
			SS	3.0	00-06	
10*	9452	25803	DS	10.9	00	
			DS	1.3	00	
			SS	2.0	00-06	
			DS	4.4	06	
11	9491	25803	DS	56.4	00	
			DS	15.3	06	
			SS	69.0	00-06	
			SS	17.0	06-12	
			DS	11.2	12	

*Measurement Type: DS = Delta Scintillometer
SS = Soil Sample by Laboratory Analysis
TC = Total Count Borehole (deconvolved)

*1984 Sample Location

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Table B-2. Upper and Lower Montezuma Canyon - 1984 and 1987 Radiological Investigation Data (continued)

Location Number	Grid Coordinates		Measurement Type[a]	Ra-226 Concentration (pCi/g)	Depth (inches)	Comments
	Northing	Easting				
12	9764	25803	DS	5.0	00	
			DS	1.9	06	
			SS	6.0	00-06	
13	9529	26203	DS	3.0	00	
			DS	2.9	06	
			SS	3.0	00-06	
14	9639	26203	DS	4.7	00	
			DS	5.0	06	
			SS	4.0	00-06	
15	9839	26203	DS	5.1	00	
			DS	5.0	06	
16*	9444	26383	DS	11.2	00	
			TC	7.1	00	
			SS	13.0	00-06	
			DS	17.9	06	
			TC	9.2	06	
			SS	4.8	12	
			DS	19.0	06-12	
			TC	11.8	12	
			TC	2.9	18	
			TC	3.0	22	
17 *	9489	26403	DS	63.6	00	
			DS	22.5	06	
			SS	131.0	00-06	
			DS	8.4	12	
			SS	42.0	06-12	
			DS	6.7	18	
			SS	6.0	12-18	
18	9431	26603	DS	2.8	00	
			DS	2.7	06	
			DS	2.0	00-06	
19*	9520	26603	DS	9.3	00	
			DS	5.5	06	
			SS	10.0	00-06	
20*	9620	26603	DS	9.0	00	
			DS	2.3	00	
			SS	2.0	00-06	

[a]Measurement Type: DS = Delta Scintillometer
SS = Soil Sample by Laboratory Analysis
TC = Total Count Borehole (deconvolved)

*1984 Sample Location

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Table B-2. Upper and Lower Montezuma Canyon - 1984 and 1987 Radiological Investigation Data (continued)

Location Number	Grid Coordinates		Measurement Type[a]	Ra-226 Concentration (pCi/g)	Depth (inches)	Comments
	Northing	Easting				
21	9720	26603	DS	3.5	00	
			SS	2.0	00-06	
22*	9494	26793	DS	7.4	00	
			DS	7.6	06	
.			SS	12.0	00-06	
23*	9514	26803	DS	22.6	00	Creek Bed
			SS	25.0	00-06	
			DS	62.5	06	
			DS	7.1	12	
			SS	103.0	06-12	
24	9232	27003	DS	2.6	00	
			DS	3.8	06	
			SS	1.0	00-06	
25	9391	27003	DS	4.8	00	
			SS	3.0	00-06	
			DS	6.0	06	
			SS	2.0	06-12	
			DS	4.5	12	
26	9591	27003	DS	3.6	00	
			SS	4.0	00-06	
27*	9264	27203	DS	0.3	00	
			SS	3.0	00-06	
			SS	6.0	06-12	
28*	9294	27203	DS	28.0	00	
			DS	33.3	06	
			SS	40.0	00-06	
			DS	9.4	12	
			SS	67.0	06-12	
			DS	8.5	18	
29	9162	27403	DS	3.1	00	
			SS	1.0	00-06	
30	9262	27403	DS	14.8	00	
			DS	18.8	06	
			SS	19.0	00-06	
			SS	28.0	06-12	
			DS	4.1	12	

[a]Measurement Type: DS = Delta Scintillometer
SS = Soil Sample by Laboratory Analysis
TC = Total Count Borehole (deconvolved)

*1984 Sample Location

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Table B-2. Upper and Lower Montezuma Canyon - 1984 and 1987 Radiological Investigation Data (continued)

Location Number	Grid Coordinates		Measurement Type[a]	Ra-226 Concentration (pCi/g)	Depth (inches)	Comments
	Northing	Easting				
31	9330	27403	DS	7.3	00	
			SS	5.0	00-06	
			DS	9.4	06	
			SS	8.0	06-12	
			DS	6.3	12	
32	9430	27403	DS	5.2	00	
			SS	2.0	00-06	
33	9264	27783	DS	94.3	00	Creek Bed
			DS	71.8	06	
			SS	139.0	00-06	
			SS	109.0	06-12	
			DS	33.1	12	
34	9414	27783	DS	2.9	00	
35*	9216	27795	DS	2.4	00	
			DS	3.0		
			SS	1.6	06	
			SS	1.5	00-06	
					06-12	
36*	9254	27795	DS	2.3		
			SS	1.7	00	
			DS	2.8	00-06	
			SS	1.1	06	
					06-12	
37*	9264	27795	DS	14.0		
			DS	4.7	00	
			SS	41.5	06	
			DS	5.5	00-06	
			SS	4.8	12	
					12-18	
38*	9274	27795	DS	21.1		
			DS	14.3	00	
			SS	5.9	06	
			DS	33.5	00-06	
			SS	5.4	12	
			SS	8.8	06-12	
			DS	90.8	12-18	
			SS	89.3	18	
			DS	190.9	18-24	
					24	
39	9229	27803	DS	3.4		
			SS	2.0	00	
					00-06	
40	8975	28203	DS	4.6		
					00	

*Measurement Type: DS = Delta Scintillometer
SS = Soil Sample by Laboratory Analysis
TC = Total Count Borehole (deconvolved)

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Table B-2. Upper and Lower Montezuma Canyon - 1984 and 1987 Radiological Investigation Data (continued)

Location Number	Grid Coordinates		Measurement Type[a]	Ra-226 Concentration (pCi/g)	Depth (inches)	Comments
	Northing	Easting				
41	9060	28203	DS	44.6	00	
			DS	48.7	00	
			DS	123.6	06	
			SS	21.0	00-06	
			DS	41.4	12	
			SS	130.0	06-12	
42	9094	28203	DS	83.4	00	
			SS	98.0	00-06	
			DS	131.5	06	
			SS	139.0	06-12	
			DS	80.9	12	
43	9120	28203	DS	5.6	00	
44	9220	28203	DS	2.6	00	
45*	8981	28323	DS	2.5	00	
			DS	3.1	06	
			SS	1.8	00-06	
			DS	3.0	12	
			SS	1.9	06-12	
			SS	1.7	12-18	
46*	9050	28323	DS	3.1	00	Creek Bed
			DS	5.7	06	
			SS	2.5	00-06	
			DS	5.7	12	
			SS	4.9	06-12	
			SS	5.8	12-18	
47*	9064	28323	DS	3.8	00	Creek Bed
			DS	1.6	06	
			SS	4.0	00-06	
			SS	2.7	06-12	
48*	9077	28323	DS	39.3	00	
			SS	50.1	00-06	
			DS	45.9	06	
			SS	52.4	06-12	
			DS	39.8	12	
			DS	41.5	18	
			SS	52.4	12-18	
			DS	46.5	24	
			SS	42.0	18-24	

*Measurement Type: DS = Delta Scintillometer
                    SS = Soil Sample by Laboratory Analysis
                    TC = Total Count Borehole (deconvolved)

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Table B-2. Upper and Lower Montezuma Canyon - 1984 and 1987 Radiological Investigation Data (continued)

Location Number	Grid Coordinates		Measurement Type[a]	Ra-226 Concentration (pCi/g)	Depth (inches)	Comments
	Northing	Easting				
49*	9107	28323	DS	40.5	00	Creek Bed
			DS	22.2	06	
			SS	63.3	00-06	
			SS	42.2	06-12	
			DS	16.0	12	
			DS	16.3	18	
			SS	12.0	12-18	
			SS	10.9	18-24	
50	8841	28603	DS	4.6	00	
51	8886	28603	DS	17.2	00	
			SS	11.0	00-06	
			DS	29.0	06	
			SS	32.0	06-12	
			DS	4.7	12	
52	8986	28603	DS	5.6	00	
			DS	3.9	06	
			SS	3.0	00-06	
53	8931	29003	DS	3.9	00	
54	8962	29003	DS	22.3	00	
			DS	42.8	06	
			SS	4.0	00-06	
			SS	17.0	06-12	
			DS	75.8	12	
55	8991	29003	DS	1.4	00	
56*	8254	29343	DS	2.4	00	
			SS	3.0	00-06	
			DS	0.3	06	
			SS	1.5	06-12	
57	8598	29403	DS	5.1	00	
58	8648	29403	DS	161.5	00	
			DS	242.8	06	
			SS	130.0	00-06	
			DS	256.0	12	
			SS	182.0	06-12	
			DS	59.8	18	
			SS	322.0	12-18	

*Measurement Type: DS = Delta Scintillometer
SS = Soil Sample by Laboratory Analysis
TC = Total Count Borehole (deconvolved)

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Table B-2. Upper and Lower Montezuma Canyon - 1984 and 1987 Radiological Investigation Data (continued)

Location Number	Grid Coordinates		Measurement Type[a]	Ra-226 Concentration (pCi/g)	Depth (inches)	Comments
	Northing	Easting				
59	8683	29403	DS	169.1	00	
			DS	162.0	06	
			SS	184.0	00-06	
			SS	213.0	06-12	
			DS	55.6	12	
60	8733	29403	DS	3.7	00	
61*	8652	29435	DS	54.1	00	
			SS	107.3		
			DS	26.9	00-06	
			SS	42.8	06	
			DS	18.2	06-12	
			DS	11.1	12	
			SS	27.5	18	
			SS	11.1	12-18	
			DS	7.7	18-24	
					24	
62*	8662	29435	DS	5.2		Creek Bed
			DS	6.0	00	
			SS	5.8	06	
			SS	4.8	00-06	
			DS	7.4	06-12	
			SS	4.9	12	
					12-18	
63*	8679	29435	DS	113.0		
			SS	249.3	00	
			DS	39.0	00-06	
			DS	32.7	06	
			SS	62.8	12	
			DS	38.7	06-12	
			SS	21.8	18	
			SS	28.0	12-18	
			DS	28.4	18-24	
			SS	32.0	24	
					24-30	
64*	8707	29435	DS	0.3		
			DS	1.7	00	
			DS	0.3	00	
			DS	1.6	06	
			SS	1.2	06	
			SS	1.2	00-06	
			SS	1.9	06-12	
					12-18	
65*	8694	30073	DS	1.7		
			DS	1.6	00	
			SS	1.9	06	
					00-06	

[a]Measurement Type: DS = Delta Scintillometer
SS = Soil Sample by Laboratory Analysis
TC = Total Count Borehole (deconvolved)

*1984 Sample Location

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Table B-2. Upper and Lower Montezuma Canyon - 1984 and 1987 Radiological Investigation Data (continued)

Location Number	Grid Coordinates		Measurement Type[a]	Ra-226 Concentration (pCi/g)	Depth (inches)	Comments
	Northing	Easting				
66*	8403	30173	DS	18.6	00	
			DS	15.2	06	
			SS	91.3	00-06	
			DS	3.7	12	
			SS	33.1	06-12	
			DS	4.2	18	
			SS	10.1	12-18	
67*	8414	30173	DS	5.4	00	Creek Bed
			SS	7.2	00-06	
			DS	5.1	06	
			DS	4.0	12	
			SS	3.5	06-12	
68*	8421	30173	DS	10.2	00	
			SS	12.6	00-06	
			DS	10.2	06	
			SS	13.8	06-12	
			DS	11.7	12	
			DS	17.6	18	
			SS	10.4	12-18	
69*	8234	30233	DS	1.0	00	
			DS	1.0	06	
			SS	0.7	06-12	
70*	8085	31258	DS	6.1	00	Creek Bed
			DS	5.0	06	
			SS	9.2	00-06	
			SS	4.2	06-12	
			DS	5.9	12	
71*	8090	31258	DS	29.8	00	.
			SS	63.7	00-06	
			DS	2.7	06	
			SS	9.8	06-12	
72*	8145	31258	DS	0.4	00	
			DS	1.0	06	
			SS	1.2	00-06	
			SS	0.7	06-12	
73*	7984	32123	DS	1.0	00	
			DS	1.0	06	
			SS	1.0	00-06	

[a]Measurement Type: DS = Delta Scintillometer
SS = Soil Sample by Laboratory Analysis
TC = Total Count Borehole (deconvolved)

*1984 Sample Location

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Table B-2. Upper and Lower Montezuma Canyon - 1984 and 1987 Radiological Investigation Data (continued)

Location Number	Grid Coordinates		Measurement Type[a]	Ra-226 Concentration (pCi/g)	Depth (inches)	Comments
	Northing	Easting				
74*	7856	32173	DS	5.4	00	
			DS	7.0	06	
			SS	5.3	00-06	
			DS	7.0	12	
			SS	5.3	06-12	
			DS	9.9	18	
			SS	7.0	12-18	
75*	7874	32173	DS	3.5	00	
			SS	4.8	00-06	
			DS	6.2	06	
			DS	4.0	12	
			SS	7.6	06-12	
			SS	6.4	12-18	
			SS	11.7	18-24	
76*	7882	32173	DS	26.7	00	
			DS	9.4	06	
			SS	51.0	00-06	
			DS	3.2	12	
			SS	11.9	06-12	
			SS	4.3	12-18	
77*	7794	32203	DS	1.1	00	
			DS	1.7	06	
			SS	1.2	00-06	
78*	7817	33569	DS	1.0	00	
			DS	1.0	06	
			SS	0.9	00-06	
79*	7777	33576	DS	7.6	00	Creek Bed
			DS	1.5	06	
			SS	5.2	00-06	
			SS	1.8	06-12	
80*	7760	33578	DS	2.0	00	Creek Bed
			DS	4.0	06	
			SS	1.2	00-06	
			SS	3.1	06-12	
			DS	6.6	12	
			DS	10.0	18	
			SS	3.9	12-18	

aMeasurement Type: DS = Delta Scintillometer
SS = Soil Sample by Laboratory Analysis
TC = Total Count Borehole (deconvolved)

*1984 Sample Location

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Table B-2. Upper and Lower Montezuma Canyon - 1984 and 1987 Radiological Investigation Data (continued)

Location Number	Grid Coordinates		Measurement Type[a]	Ra-226 Concentration (pCi/g)	Depth (inches)	Comments
	Northing	Easting				
81*	7745	33580	DS	0.9	00	
			SS	0.8	00-06	
			DS	1.4	06	
			SS	1.1	06-12	
82*	7735	33582	DS	3.2	00	
			DS	1.8	06	
			SS	1.1	00-06	
			SS	0.8	06-12	
			SS	0.8	12-18	
83*	7679	34713	DS	1.5	00	
			DS	1.8	06	
			SS	0.7	00-06	
			SS	0.8	06-12	
84*	7702	34713	DS	2.3	00	
			DS	3.0	06	
			SS	1.2	00-06	
			DS	2.4	12	
			SS	1.1	06-12	
			SS	1.0	12-18	
85*	7731	34713	DS	2.6	00	Creek Bed
			SS	2.2	00-06	
			DS	4.5	06	
			SS	4.3	06-12	
			DS	6.4	12	
			SS	7.6	12-18	
86*	7737	34713	DS	82.3	00	
			DS	29.1	06	
			SS	111.6	00-06	
			DS	6.6	12	
			SS	17.5	06-12	
			SS	4.7	12-18	
87	7759	34713	DS	1.5	00	
			DS	1.0	06	
			SS	1.9	06-16	
			SS	1.1	16-12	
88	7814	35073	DS	1.9	00	
			SS	1.0	00-06	

[a]Measurement Type: DS = Delta Scintillometer
SS = Soil Sample by Laboratory Analysis
TC = Total Count Borehole (deconvolved)

*1984 Sample Location

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Table B-2. Upper and Lower Montezuma Canyon - 1984 and 1987 Radiological Investigation Data (continued)

Location Number	Grid Coordinates		Measurement Type[a]	Ra-226 Concentration (pCi/g)	Depth (inches)	Comments
	Northing	Easting				
89	7614	35163	DS	28.2	00	Abandoned
			DS	53.9	06	Cabin Area
			SS	12.0	00-06	
			DS	70.6	12	
			SS	25.0	06-12	
			DS	152.1	18	
			SS	31.0	12-18	
90*	7232	35414	DS	1.7	00	
			SS	1.6	00-06	
			DS	1.7	06	
			SS	1.3	06-12	
91*	7244	35428	DS	33.7	00	
			DS	88.1	06	
			SS	38.8	00-06	
			DS	10.9	12	
			SS	165.1	06-12	
			DS	5.2	18	
			SS	6.1	12-18	
92*	7249	35433	DS	5.1	00	Creek Bed
			SS	4.4	00-06	
			DS	4.4	06	
			DS	3.1	12	
			SS	7.0	06-12	
93*	7259	35444	DS	13.5	00	
			SS	11.1	00-06	
			DS	55.5	06	
			DS	100.8	12	
			SS	28.7	06-12	
			SS	54.7	12-18	
			DS	200.2	18	
			SS	208.3	18-24	
94*	7269	35445	DS	1.7	00	
			SS	1.2	00-06	
			DS	0.6	06	
			SS	1.1	06-12	
95*	6323	36278	DS	1.1	00	
			SS	1.7	06	
			DS	1.1	00-06	
			SS	1.0	06-12	

[a]Measurement Type: DS = Delta Scintillometer
                           SS = Soil Sample by Laboratory Analysis
                           TC = Total Count Borehole (deconvolved)

*1984 Sample Location

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Table B-2. Upper and Lower Montezuma Canyon - 1984 and 1987 Radiological Investigation Data (continued)

Location Number	Grid Coordinates		Measurement Type[a]	Ra-226 Concentration (pCi/g)	Depth (inches)	Comments
	Northing	Easting				
96*	6359	36329	DS	4.0	00	Creek Bed
			DS	2.3	06	
			SS	1.9	00-06	
			SS	3.3	06-12	
97	6054	36333	DS	35.3	00	Vega Creek
			DS	53.5	06	Confluence
			SS	37.0	00-06	
			SS	63.0	06-12	
			DS	28.2	12	
98*	6369	36344	DS	2.1	00	
			DS	2.8	06	
			SS	1.4	00-06	
			SS	1.3	06-12	
99	6254	36443	DS	1.5	00	
			SS	1.0	00-06	

*Measurement Type: DS = Delta Scintillometer
SS = Soil Sample by Laboratory Analysis
TC = Total Count Borehole (deconvolved)

*1984 Sample Location

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Table B-3. Upper and Lower Montezuma Canyon - 1984 and 1987 Analytical Investigation Data

Location Number	Grid Coordinates		Soil Sample	Concentration		
	Northing	Easting		Ra-226 (pCi/g)	Thorium (ppm)	Potassium (%)
1	9424	25403	0-6	5	<3	1.4
2	9542	25403	0-6	19	<3	1.8
			6-12	13	<2	2.0
3	9642	25403	0-6	3	8	2.1
5	9964	25403	0-6	45	<4	2.1
6	9304	25603	0-6	6	<0.3	26.8
7*	9344	25603	0-6	2	<0.1	27.6
8*	9764	25603	0-6	34	<0.0	21.8
			6-12	23	<0.0	23.4
9	9252	25803	0-6	3	<2	1.8
10*	9452	25803	0-6	2	<0.2	27.6
11	9491	25803	0-6	69	<4	1.2
			6-12	17	7	1.6
12	9764	25803	0-6	6	8	2.5
13	9529	26203	0-6	3	4	1.6
14	9639	26203	0-6	4	9	1.8
16*	9444	26383	0-6	13	<0.4	26.0
			6-12	19	<0.5	22.6
17*	9489	26403	0-6	131	<5.8	<8.4
			6-12	42	<1.1	17.6
			12-18	6	<0.0	26.0
18	9431	26603	0-6	2	<2	1.0
19	9520	26603	0-6	10	7	1.4
20*	9620	26603	0-6	2	<0.3	26.8
21	9720	26603	0-6	2	8	1.8
22*	9494	26793	0-6	12	<0.8	<0.8
23*	9514	26803	0-6	25	<1.5	2.5
			6-12	103	<3.9	<5.9

* 1984 Sample Locations

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Table B-3. Upper and Lower Montezuma Canyon - 1984 and 1987
Analytical Investigation Data (continued)

Location Number	Grid Coordinates		Soil Sample	Concentration		
	Northing	Easting		Ra-226 (pCi/g)	Thorium (ppm)	Potassium (%)
24	9232	27003	0-6	1	<2	1.7
25	9391	27003	0-6	3	8	2.3
			6-12	2	9	2.3
26	9591	27003	0-6	4	8	1.7
27*[2]	9264	27203	0-6	3	<0.4	<0.8
			12-18	6	<0.1	<0.0
28*	9294	27203	0-6	40	<2.0	2.5
			6-12	67	<2.4	15.1
29	9162	27403	0-6	1	5	2.1
30	9262	27403	0-6	19	<3	1.3
			6-12	28	<3	1.4
31	9330	27403	0-6	5	7	2.1
			6-12	8	2	1.9
32	9430	27403	0-6	2	12	2.6
33	9264	27783	0-6	139	4	0.8
			6-12	109	6	1.2
35*	9216	27795	0-6	1.6	<0.1	20.0
			6-12	1.5	<0.2	19.1
36*	9254	27795	0-6	1.7	0.7	19.6
			6-12	1.1	0.9	10.4
37*	9264	27795	0-6	41.5	<0.7	11.3
			12-18	4.8	0.6	17.1
38*	9274	27795	0-6	5.9	<0.2	14.3
			6-12	5.4	0.9	13.4
			12-18	8.8	1.2	16.2
			18-24	89.3	<1.3	<2.2
39	9229	27803	0-6	2	10	1.5
41	9060	28203	0-6	21	4	1.4
			6-12	130	5	1.6
42	9094	28203	0-6	98	7	1.6
			6-12	139	4	1.4
45*	8981	28323	0-6	1.8	0.8	17.6
			6-12	1.9	0.9	19.9
			12-18	1.7	0.5	17.3

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Table B-3. Upper and Lower Montezuma Canyon - 1984 and 1987
Analytical Investigation Data (continued)

Location Number	Grid Coordinates		Soil Sample	Concentration		
	Northing	Easting		Ra-226 (pCi/g)	Thorium (ppm)	Potassium (%)
46[3]*						
	9050	28323	0-6	2.5	0.9	16.9
			6-12	4.9	0.9	17.0
			12-18	5.8	0.9	21.8
47*						
	9064	28323	0-6	4.0	0.6	16.9
			6-12	2.7	1.1	20.4
48*						
	9077	28323	0-6	50.1	<0.9	13.6
			6-12	52.4	<0.9	15.0
			12-18	52.4	<0.8	17.9
			18-24	42	<0.8	16.2
49*						
	9107	28323	0-6	63.3	<1.1	17.5
			6-12	42.2	<0.9	11.4
			12-18	12	0.6	17.8
			18-24	10.9	0.9	15.6
51						
	8886	28603	0-6	11	7	1.8
			6-12	32	<8	1.5
52						
	8986	28603	0-6	3	10	3.1
54						
	8962	29003	0-6	4	10	2.0
			6-12	17	6	1.4
56*						
	8254	29343	0-6	3.0	0.9	13.1
			6-12	1.5	0.8	15.3
58						
	8648	29403	0-6	130	2	1.2
			6-12	182	5	0.8
			12-18	322	1	1.4
59						
	8683	29403	0-6	184	2	1.1
			6-12	213	3	1.4
61*						
	8652	29435	0-6	107.3	<1.9	8.1
			6-12	42.8	0.7	14.6
			12-18	27.5	<0.4	14.0
			18-24	11.1	<0.2	17.3
63*						
	8679	29435	0-6	249.3	<2.8	<8.2
			6-12	62.8	<1.0	14.5
			12-18	21.8	<0.3	14.5
			18-24	28.0	<0.4	9.6
			24-30	32.0	1.7	15.0
65*						
	8694	30073	0-6	1.9	0.8	13.3
66*						
	8403	30173	0-6	91.3	<1.3	<1.7
			6-12	33.1	<0.5	11.4
			12-18	10.1	<0.3	15.2

* 1984 Sample Locations

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Table B-3. Upper and Lower Montezuma Canyon - 1984 and 1987 Analytical Investigation Data (continued)

Location Number	Grid Coordinates		Soil Sample	Concentration		
	Northing	Easting		Ra-226 (pCi/g)	Thorium (ppm)	Potassium (%)
67**	8414	30173	0-6	7.2	1.1	13.9
			6-12	3.5	0.8	13.5
68*	8421	30173	0-6	12.6	0.9	14.1
			6-12	13.8	1.0	15.0
			12-18	10.4	0.8	19.3
69*	8234	30233	6-12	0.7	<0.2	6.8
70*	8085	31258	0-6	9.2	1.2	16.2
			6-12	4.2	<0.2	14.5
71*	8090	31258	0-6	63.7	<1.1	17.9
			6-12	9.8	0.7	13.2
72*	8145	31258	0-6	1.2	0.2	9.4
			6-12	0.7	<0.2	10.4
73*	7984	32123	0-6	1.0	<0.1	8.0
74*	7856	32173	0-6	5.3	0.7	15.2
			6-12	5.3	0.5	15.4
			12-18	7.0	1.0	13.1
75*	7874	32173	0-6	4.8	0.9	14.8
			6-12	7.6	0.7	13.8
			12-18	6.4	<0.3	16.6
			18-24	11.7	0.6	15.4
76*	7882	32173	0-6	51.0	<0.8	12.0
			6-12	11.9	0.9	13.8
			12-18	4.3	1.4	14.5
77*	7794	32203	0-6	1.2	0.5	14.2
78*	7817	33569	0-6	0.9	<0.2	7.9
79*	7777	33576	0-6	5.2	1.7	13.5
			6-12	1.8	0.9	14.4
80*	7760	33578	0-6	1.2	0.7	16.7
			6-12	3.1	<0.2	15.8
			12-18	3.9	0.6	16.0
81*	7745	33580	0-6	0.8	<0.2	19.3
			6-12	1.1	1.0	16.4
82*	7735	33582	0-6	1.1	1.0	18.6
			6-12	0.8	0.7	7.9
			6-12	0.8	0.9	15.8
83*	7679	34713	0-6	1.9	0.8	8.4

* 1984 Sample Locations

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Table B-3. Upper and Lower Montezuma Canyon - 1984 and 1987 Analytical Investigation Data (continued)

Location Number	Grid Coordinates		Soil Sample	Concentration		
	Northing	Easting		Ra-226 (pCi/g)	Thorium (ppm)	Potassium (%)
84*5	7702	34713	0-6	1.2	0.9	16.0
			6-12	1.1	1.3	15.0
			12-18	1.0	1.5	14.8
85*	7731	34713	0-6	2.2	0.9	15.9
			6-12	4.3	0.9	13.8
			12-18	7.6	0.7	14.4
86*	7737	34713	0-6	111.6	<0.9	<2.6
			6-12	17.5	0.7	13.3
			12-18	4.7	<0.2	15.7
90*	7232	35414	0-6	1.6	1.5	
			6-12	1.3	1.3	
91*	7244	35428	0-6	38.8	<0.7	
			6-12	165.1	<2.6	
			12-18	6.1	0.4	
92*	7249	35433	0-6	4.4	0.9	14.9
			6-12	7.0	0.9	17.0
93*	7259	35444	0-6	11.1	1.1	11.5
			6-12	28.7	<0.4	12.6
			12-18	54.7	1.0	15.4
94*	7269	35455	0-6	1.2	0.7	13.5
			6-12	1.1	0.9	13.0
95*	6323	36278	0-6	1.1	0.6	17.9
			6-12	1.0	1.3	17.3
96*	6359	36329	0-6	1.9	1.0	18.6
			6-12	3.3	1.0	16.0
98*	6369	36344	0-6	1.4	0.7	17.0
			6-12	1.3	1.0	15.9

* 1984 Sample Locations

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Table B-4. Metals Analytical Results Obtained from the 1994 Confirmatory Soil Sampling

Designation	Depth	Ag	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg	Mn	Mo	Ni	Pb	Sb	Se	Sn	Tl	U	V	Zn
S94-015	0-6"	0.20 U	8,870	5.8	130	0.59 B	0.20 U	5.3 B	6.9	15.2	10,900	0.03 B	335	1.5 B	11.7	10.4	7.4 U,N	0.60 U	1.4 N	0.20 U	12.2	74.2	50
S94-016	0-6"	0.20 U	12,100	9.0 S	184	0.58 B	0.21 B	6.9 B	9.8	55.0	14,600	0.02 B	390	1.7 B	12.4	12.5	0.20 U,N	1.5 +	2.2	0.23 B	17.2	83.7	54.4
	0-6" (Dup)	0.20 U	10,000	6.7	173	0.50 B	0.27 B	6.9 B	8.0	51.3	13,200	0.02 B	357	1.6 B	12.4	11.8	0.20 U,N	3.0 U	2.2	0.22 B	17.1	80.9	52.4
	6-12"	0.29 B	6,310	7.2	200	0.36 B	0.35 B	6.0 B	5.2	116	10,400	0.02 U	279	1.5 B	9.7	13.4	0.20 U,N	3.0 U,W	2.2	0.20 U	18.9	102	48.3
	12-18"	0.26 B	8,390	6.7	189	0.45 B	0.35 B	6.9 B	7.0	106	11,600	0.02 B	236	1.8 B	12.3	14.2	0.20 U,N	1.4 S	2.4	0.23 B	17.1	82.9	51.2
SS94-001	0-6"	0.20 U	6,380	5.3 +	158	0.44 B	0.29 B	5.8 B	5.2	55.8	10,100	0.03 B	356	1.7 B	10.1	15.1	7.4 U,N	0.60 U	1.9 N	0.20 U	31.2	132	52.1
	6-12"	0.20 U	6,770	7.0	430	0.47 B	0.20 U	4.0 B	5.7	22.0	10,400	0.02 B	358	1.5 B	11.4	19.1	7.4 U,N	0.60 U,W	1.9 N	0.20 U	13.6	66.4	44.8
SS94-002	0-6"	0.20 U	9,440	5.8	139	0.68 B	0.20 U	5.1 B	7.9	20.2	11,000	0.03 B	421	0.87 B	12.6	12.2	7.4 U,N	0.60 U	1.4 N	0.20 U	6.9	40.2	56.2
	0-6" (Dup)	0.20 U	10,200	3.0 +	144	0.67 B	0.20 U	5.0 B	7.8	19.9	11,600	0.03 B	431	0.89 B	13.5	12.1	7.4 U,N	0.60 U,W	1.3 N	0.20 U	7.3	42.5	59.2
SS94-003	0-6"	0.20 U	7,790	4.4 S	165	0.50 B	0.20 U	6.0 B	6.0	76.6	10,900	0.03 B	353	1.6 B	12.2	14.2	7.4 U,N	0.03 B	1.5 N	0.20 U	16.4	68.4	54.4
	6-12"	0.20 U	7,370	8.3	184	0.51 B	0.22 B	5.1 B	5.7	36.5	11,700	0.03 B	336	1.9 B	10.7	15.1	7.4 U,N	0.60 U	2.2 N	0.20 U	23.6	159	48.5
	12-18"	0.20 U	7,210	6.7	155	0.48 B	0.20 U	4.4 B	5.5	45.8	11,600	0.03 B	315	2.1 B	12	14.1	7.4 U,N	0.60 U	1.9 N	0.20 U	19.2	106	45.9
	18-24"	0.20 U	8,010	5.4 S	148	0.51 B	0.20 U	4.7 B	6.1	21.8	11,900	0.02 B	224	2.4 B	11.3	12.3	7.4 U,N	0.60 U	2.8 N	0.20 U	12.5	62.6	47.5
	18-24" (Dup)	0.20 U	7,740	5.7 S	149	0.50 B	0.20 U	5.1 B	5.6	23.3	11,600	0.02 B	222	2.3 B	10.2	12.1	7.4 U,N	0.60 U	1.5 N	0.20 U	12.8	59.7	47.8
SS94-004	0-6"	0.20 U	6,310	8.1	167	0.51 B	0.20 U	5.2 B	5.1	71.2	9,710	0.03 B	347	1.5 B	9.7	15.1	7.4 U,N	0.60 U,W	1.8 N	0.20 U	44.1	120	47.5
	6-12"	0.20 U	6,680	5.8	147	0.52 B	0.43 B	5.3 B	5.4	30.9	10,800	0.03 B	400	2.3 B	10	12.2	7.4 U,N	0.60 U	1.7 N	0.20 U	17.9	44.2	42.5
	12-18"	0.29 B	5,990	10.4	206	0.38 B	0.25 B	6.6 B	4.6	238	10,800	0.02 B	441	3.5 B	11	18.4	7.4 U,N	1.3 S	1.9 N	0.20 B	20.3	99.5	55.8
	18-24"	0.22 B	6,190	19.7 +	245	0.40 B	0.49 B	9.5 B	5.0	337	13,100	0.02 B	651	6.5 B	10.7	22.3	7.4 U,N	1.8 +	1.8 N	0.26 B	23.4	187	66.9
SS94-005	0-6"	0.20 U	7,320	10.3	173	0.53 B	0.24 B	5.9 B	6.0	83.8	11,000	0.03 B	391	1.9 B	10.9	14.5	7.4 U,N	0.60 U	2.0 N	0.20 U	33.5	180	49.5
	6-12"	0.20 U	6,800	6.2	141	0.43 B	0.20 U	4.4 B	4.8	12.2	12,300	0.02 B	346	1.8 B	8.6	11.3	7.4 U,N	0.60 U,W	2.0 N	0.20 U	8.9	45.2	42.8
SS94-006	0-6"	0.20 U	9,060	3.0 B,S	141	0.61 B	0.20 U	5.7 B	7.3	16.9	12,100	0.02 U	374	0.95 B	11.5	12.2	7.4 U,N	0.60 U	1.6 N	0.20 U	6.4	34.2	60.5
	6-12"	0.20 U	8,650	4.6	140	0.65 B	0.20 U	5.4 B	6.3	18.4	11,600	0.03 B	372	0.95 B	11.5	12.6	7.4 U,N	0.60 U	1.5 N	0.20 U	8.1	41	55.2
	12-18"	0.20 U	8,760	4.3	136	0.65 B	0.20 U	4.7 B	6.6	13.8	11,600	0.03 B	375	0.89 B	13.1	12.3	7.4 U,N	0.50 U	1.5 N	0.20 U	6	26.4	54.6
	18-24"	0.20 U	8,300	4.4	136	0.63 B	0.20 U	4.0 B	6.6	13.0	11,400	0.03 B	377	0.80 B	10.7	12.1	7.4 U,N	0.50 U	1.4 N	0.20 U	5	24.3	54.8
	18-24" (Dup)	0.20 U	9,070	4.3	136	0.66 B	0.20 U	4.8 B	7.4	13.9	12,000	0.03 B	386	0.90 B	12.7	13.1	7.4 U,N	0.50 U	1.6 N	0.22 B	4.8	24.7	60.7
SS94-007	0-6"	0.43 B	8,510	4.3	147	0.66 B	0.20 U	5.4 B	7.2	13.7	10,100	0.02 U	430	0.73 B	10.6	10.6	7.4 U,N	0.60 U	1.7 N	0.20 U	5.1	27.2	40
SS94-008	0-6"	0.20 U	8,410	5.6	139	0.56 B	0.20 U	4.6 B	6.3	12.6	11,400	0.02 U	422	0.94 B	10.8	11.8	7.4 U,N	0.63 U,W	1.5 N	0.20 U	5.4	34.4	47.2
SS94-009	0-6"	0.21 B	7,840	11.4 +	231	0.50 B	0.78 B	9.6 B	7.7	137	8,190	0.02 U	353	2.5 B	11.1	22.5	7.4 U,N	1.4 +	2.4 N	0.29 B	98.9	488	66.4
	6-12"	0.28 B	7,770	16.2 +	252	0.52 B	0.78 B	11.4	8.5	155	8,550	0.02 U	337	2.7 B	12.1	23.8	7.4 U,N	0.64 B,W	2.6 N	0.30 B	118	673	57
	12-18"	0.20 U	8,700	12.0 +	203	0.50 B	0.32 B	6.4 B	7.7	49.1	11,300	0.02 U	359	2.1 B	11.5	16.2	7.4 U,N	0.70 B,W	2.4 N	0.22 B	54.9	364	47.5
	18-24"	0.20 U	7,060	8.8 +	178	0.39 B	0.20 U	5.1 B	5.9	41.0	12,100	0.02 U	337	1.9 B	10.4	11.5	7.4 U,N	0.60 U	2.2 N	0.20 U	29.3	64.3	43.2
SS94-010	0-6"	0.20 U	8,730	8.3	148	0.47 B	0.20 U	4.6 B	6.4	23.6	10,800	0.02 U	383	1.3 B	9.1	10.0	7.4 U,N	0.60 U	2.1 N	0.20 U	21.8	126	38.4
	6-12"	0.20 U	5,520	4.9 S	125	0.39 B	0.20 U	4.6 B	4.5	23.6	8,850	0.02 U	164	1.1 B	7.8 B	10.1	7.4 U,N	0.60 U	2.3 N	0.20 U	28.2	166	32.8
	12-18"	0.20 U	6,700	5.3	172	0.46 B	0.20 U	5.0 B	5.4	28.7	10,800	0.02 U	222	1.4 B	8.7	10.1	7.4 U,N	0.60 U	2.0 N	0.20 U	14.2	65.8	39.6
	18-24"	0.20 U	8,460	5.8	173	0.52 B	0.20 U	5.4 B	7.0	34.1	11,400	0.02 U	167	1.5 B	11.5	15.7	7.4 U,N	0.60 U	2.2 N	0.20 U	18.9	114	44.2
SS94-011	0-6"	0.20 U	7,350	8.2	204	0.48 B	0.20 U	5.0 B	5.9	46.6	12,000	0.02 U	327	1.9 B	10.3	11.7	7.4 U,N	0.60 U	2.2 N	0.20 U	16.1	64	45.6
	0-6" (Dup)	0.20 U	8,370	6.8	178	0.47 B	0.20 U	5.6 B	6.3	18.8	11,900	0.02 U	359	2.3 B	10.1	12.2	7.4 U,N	0.60 U	2.2 N	0.20 U	15.5	131	39.7
	6-12"	0.20 U	7,470	11.5	219	0.52 B	0.28 B	6.5 B	6.5	80.6	12,100	0.02 U	373	2.5 B	11.9	15.7	7.4 U,N	0.60 U	2.1 N	0.20 U	30.5	182	52.9
	12-18"	0.20 U	7,220	8.8	156	0.51 B	0.20 U	5.5 B	5.5	27.1	12,000	0.02 U	412	3.7 B	10.9	14.3	7.4 U,N	0.60 B	1.7 N	0.20 U	18	82.6	53
	18-24"	0.20 U	7,990	13.7	157	0.48 B	0.20 U	5.1 B	6.3	17.4	13,700	0.02 U	461	4.6 B	11.4	11.6	7.4 U,N	0.62 B,W	1.8 N	0.20 U	15.9	141	54.6
SS94-012	0-6"	0.20 U	8,770	11.1 +	175	0.39 B	0.28 B	6.4 B	7.0	92	15,000	0.02 U	392	2.0 B	11.0	12.4	7.4 U,N	0.95 B,+	2.6	0.21 B	18.9	89.6	56
	6-12"	0.20 U	9,700	11.4	209	0.45 B	0.33 B	7.3 B	7.9	180	15,500	0.02 U	422	1.9 B	10.9	13.4	7.4 U,N	1.0	2.6	0.24 B	20.9	131	53.8
	12-18"	0.22 B	9,910	9.4 S	197	0.46 B	0.49 B	8.0 B	8.0	168	12,300	0.02 U	360	2.0 B	11.7	14.8	0.20 U,N	1.1 S	2.6	0.27 B	22.2	144	53.2
	18-24"	0.94 B	8,550	18.4	361	0.42 B	1.2	13.6	8.2	623	11,400	0.02 U	439	2.9 B	11.2	29.6	0.20 U,N	3.9 B,W	2.5	0.40 B	45.3	343	77.2
SS94-013	0-6"	0.20 U	9,270	12.7 S	260	0.45 B	0.45 B	7.1 B	8.4	193	12,000	0.02 U	366	2.8 B	9.9	14.9	0.20 U,N	1.6	2.5	0.63 B	26.5	91.9	56.3
	6-12"	0.29 B	8,190	16.5 +	374	0.50 B	1.2	14.1	7.9	698	10,900	0.02 B	508	4.3 B	11.2	29.3	0.20 U,N	4.4 S	2.3	0.49 B	25.7	219	72.2
	12-18"	0.41 B	8,500	29.9	352	0.53 B	1.3	15.5	8.9	634	13,400	0.03 B	418	9.7 B	13.6	32.1	0.20 U,N	10.3 S	2.5	0.53 B	66.6	392	80.4
	18-24"	0.23 B	9,900	34.2 S	233	0.57 B	0.66 B	8.2 B	9.8	218	14,800	0.02 B	246	11.1	11.7	20.3	0.20 U,N	15.8	2.7	0.38 B	73.2	357	60
SS94-014	0-6"	0.20 U	9,900	4.6	144	0.48 B	0.20 U	5.4 B	8.2	14.1	11,500	0.02 U	490	0.93 B	9.2	8.5	0.20 U,N	0.60 U,W	2.4	0.20 U	8.5	37.3	33.6

Definitions of Qualifiers:

B — Value obtained from a reading less than the Required Detection Limit, but greater than or equal to the actual Detection Limit.
N — Spiked sample recovery is not within control limits.
S — Value obtained by the Method of Standard Additions (MSA).

U — Not detected. Reported value is the Detection Limit, corrected for any sample dilution during preparation and for percent solids if sample is a solid.
W — Post-digestion spike recovery for graphite furnace analysis is outside of control limits (85-115%); sample concentration is less than 50% of the spike concentration.

* — Duplicate analysis is not within control limits.
+ — Correlation coefficient for the MSA is less than 0.995.
# — Reported values were calculated using poorly defined peaks.

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Table B-5. Radionuclide Analytical Results from the 1994 Confirmatory Soil Sampling

Sample Locations		Radionuclide Activities, pCi/g				
Designation	Depth	Potassium-40	Lead-210	Radium-226	Thorium-230	Thorium-232
S94-015 .... 0-6"		18.98	<2	3.73	4.43	2.38
S94-016 .... 0-6"		13.10	6.1	6.60	12.68	<0.37
.... 0-6" (Dup)		<2.21	6.3	4.07	12.21	<0.55
.... 6-12"		<2.11	16.4	7.92	29.14	<0.67
.... 12-18"		<2.25	13.9	6.64	20.03	<0.62
SS94-001 .... 0-6"		16.30	16.3	35.53	36.16	2.95*
.... 6-12"		17.26	5.7	14.14	15.20	2.29
SS94-002 .... 0-6"		19.59	<2	3.88	4.03	1.65
.... 0-6" (Dup)		19.77	<2	3.66	3.84	1.95
SS94-003 .... 0-6"		16.64	8.4	16.64	16.34	2.66
.... 6-12"		20.05	16.1	32.86	38.69	<0.99
.... 12-18"		16.15	9.8	22.82	23.68	1.63
.... 18-24"		16.07	3.7	9.99	11.26	1.98
.... 18-24" (Dup)		16.70	4.7	10.89	11.55	<0.60
SS94-004 .... 0-6"		19.19	16.4	32.71	34.42	<0.57
.... 6-12"		15.38	4.0	8.22	7.73	<0.31
.... 12-18"		18.29	18.3	27.04	27.11	2.68
.... 18-24"		22.75*	43.8	56.73	61.61	2.56
SS94-005 .... 0-6"		16.82	20.9	48.46	44.05	1.72
.... 6-12"		16.15	3.0	7.22	8.54	<0.32
SS94-006 .... 0-6"		15.78	<2	5.71	5.57	1.65
.... 6-12"		17.51	2.8	7.58	7.37	2.53
.... 12-18"		17.81	10.1	3.12	3.57	2.33
.... 18-24"		18.78	<2	2.40	2.96	1.77*
.... 18-24" (Dup)		19.63	<2	2.56	2.88	2.15
SS94-007 .... 0-6"		20.16	<2	3.89	3.54	1.91
SS94-008 .... 0-6"		16.29	<2	3.86	4.50	1.90*
SS94-009 .... 0-6"		15.99	71.5	74.15	160.27	3.95*
.... 6-12"		16.66	88.4	136.88	202.95	5.75*
.... 12-18"		<2.08	30.0	50.94	73.79	<0.82
.... 18-24"		17.59	10.7	23.89	25.55	<0.36
SS94-010 .... 0-6"		15.94	12.3	23.13	28.29	3.24
.... 6-12"		6.82	21.8	12.83	44.91	1.70
.... 12-18"		<1.52	5.2	9.33	12.44	<0.24
.... 18-24"		7.88	12.9	14.84	26.79	1.32
SS94-011 .... 0-6"		13.18	4.0	11.99	11.09	3.04*
.... 0-6" (Dup)		13.65	6.8	11.00	10.94	2.29*
.... 6-12"		16.32	21.4	30.14	45.19	<0.69
.... 12-18"		6.68*	6.7	7.20	13.72	<0.19
.... 18-24"		<1.51	4.8	5.14	8.06	1.31
SS94-012 .... 0-6"		9.47	9.0	8.99	15.40	<0.59
.... 6-12"		<1.89	17.4	11.43	26.24	<0.32
.... 12-18"		<2.00	21.3	10.99	37.89	<0.49
.... 18-24"		<2.67	70.5	46.18	116.32	4.77*
SS94-013 .... 0-6"		<2.83	10.5	3.94	24.59	<0.82
.... 6-12"		<3.53	78.7	36.68	100.23	<1.26
.... 12-18"		<4.27	113.2	60.24	145.09	<1.64
.... 18-24"		<4.62	47.2	23.88	65.45	<0.95
SS94-014 .... 0-6"		18.60	9.7	3.43	3.01	<0.35

* Indicates that the peaks used to calculate values were poorly defined.

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Appendix C

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Monticello Operable Unit III RI/FS Work Plan

Contaminants of Potential Concern Screening

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Summary

An integral part of the Remedial Investigation and Baseline Risk Assessment process is the identification of chemicals of concern (COCs). In consideration of the complexity and importance of the COC process, a two phase approach will be used for the OU III at the Monticello Site. Phase I, following accepted guidance and using conservative screening techniques, takes place in the planning and work plan development stage and is the subject of this appendix. Compounds identified as Chemicals of potential concern (COPCs) in Phase I form the basis for the RI chemical analysis program. Phase II, a further refinement, will happen following receipt and interpretation of RI field and analytical data. An important contribution to Phase II will be incorporation of data collected from the reference area. Table C Summarizes the results of the Phase I analysis.

Table C. Summary Phase I Findings of the Contaminant of Concern Identification Process

Compound	UFSGround Water Human Health	Montezuma Creek Surface Water Human Health	Montezuma Creek Surface Water Ecologic	Montezuma Canyon Soils < 6" Human Health	Montezuma Canyon Soils < 6" Ecologic	Montezuma Canyon Soils > 6" Human Health	Montezuma Canyon Soils > 6" Ecologic
Aluminum	X		X				
Antimony	X						
Arsenic	X	X	X			X	
Boron	X	X					
Cobalt					X		X
Copper			X			X	X
Manganese	X			X		X	
Molybdenum	X	X	X				
Nitrate			X				
Tin	X	X	X		X		X
Selenium	X	X	X				X
Sodium	X	X	X				
Sulfate	X	X	X				
Elemental Uranium	X	X		X	X	X	X
Vanadium	X		X	X	X	X	X
Zinc					X		X
Gross Alpha	X	X	X				
Gross Beta	X	X	X				
Pb-210	X		X	X	X	X	X
Ra-226	X			X	X	X	X
Rn-222	X	X	X				
U-234	X	X	X	X	X	X	X
U-235	X	X	X	X	X	X	X
U-238	X	X	X	X	X	X	X
Th-230			X	X	X	X	X

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C1.0 Introduction

C1.1 Purpose

The purpose of this Appendix is to develop and document the process for identifying Chemicals of concern (COCs) for the Monticello Mill Tailings Site, Operable Unit III (OU III), Remedial Investigation/Feasibility Study. The COCs are site-related compounds whose concentrations exceed background levels, and whose presence may represent a significant threat to ecological or human health. Evaluating and identifying site contaminants, and their potential risk, is an integral part of the Remedial Investigation (RI) and Baseline Risk Assessment (BRA) process that begins with the evaluation of existing data discussed in EPA Guidance on Scoping the RI/FS (EPA 1988a). Initiation of the COC evaluation with existing data in the work plan (WP) development stage is integral to the Data Quality Objective (DQO) process, preliminary identification of ARARs, refinement of the conceptual site model, and specification of the Field Sampling and Analysis Plan (FSP).

C1.2 Overview

For OU III, the assessment of COCs will occur in a two phase process as illustrated in Figure C-1. The EPA (Region VIII) and the State of Utah will be consulted, as needed, as the process emerges on an informal basis, and more formally through the ETAG. Referring to Figure C-1, Phase I - Work Plan coincides with Work Plan development as discussed in EPA Guidance (Chapter 2, Scoping the RI/FS) (EPA 1988a). The result of this activity will be the identification of COPCs which will serve, in part, as the basis for the human health and ecological risk evaluations. COPCs will be integrated into the FSP. Phase II - RI/BRA of the process, a further refinement of the COPCs, occurs after receipt and interpretation of the field and analytical data. Important additional data obtained for this refinement step will be the reference site information developed to support the assessment of naturally occurring compounds.

As Figure C-1 indicates, Phase I and Phase II processes are to be conducted in general accordance with EPA Guidance (EPA 1989a and EPA 1994a). Phase I corresponds to the evaluation of existing data and project scoping step in WP development, and uses conservative screening evaluations. The Phase I preference is to err on the side of safety and include compounds as COPCs when faced with uncertainty. It is envisioned that Phase II, in consultation with the ETAG, will also be structured along guidelines discussed in Guidance (EPA 1989a and EPA 1994a) and industry practice.

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Figure C-1. Two Phase COPL Process.

Phase I - Work Plan, COPCs

- Summarize Analytical Data
- Assess Site Contaminant by Media
- Identify Reference Area(s)
- Assess for Contaminants of Concern

Contaminants of Potential Concern

Multimedia Analytical & Sampling Program

Phase I I- RI/BRA, COCs

- Incorporate Reference Area Data
- Incorporate RI Nature and Extent of Contamination
- Revised Based on RAGS and Region VIII Guidance*

Final Contaminants of Concern

Ecological & Human Health BRA

Explanation

BRA   Baseline Risk Assessment

COC   Contaminant of Concern

MMTS   Monticello Mill Tailings Site

COPC   Contaminant of Potential Concern

RI   Remedial Investigation

RAGS   Risk Assessment Guidance for
       Superfund-Human Health Evaluation
       Manual (EPA, 1989)

* Evaluating and Identifying
Contaminants of Concern for Human
Health (EPA Region VIII, 1994).
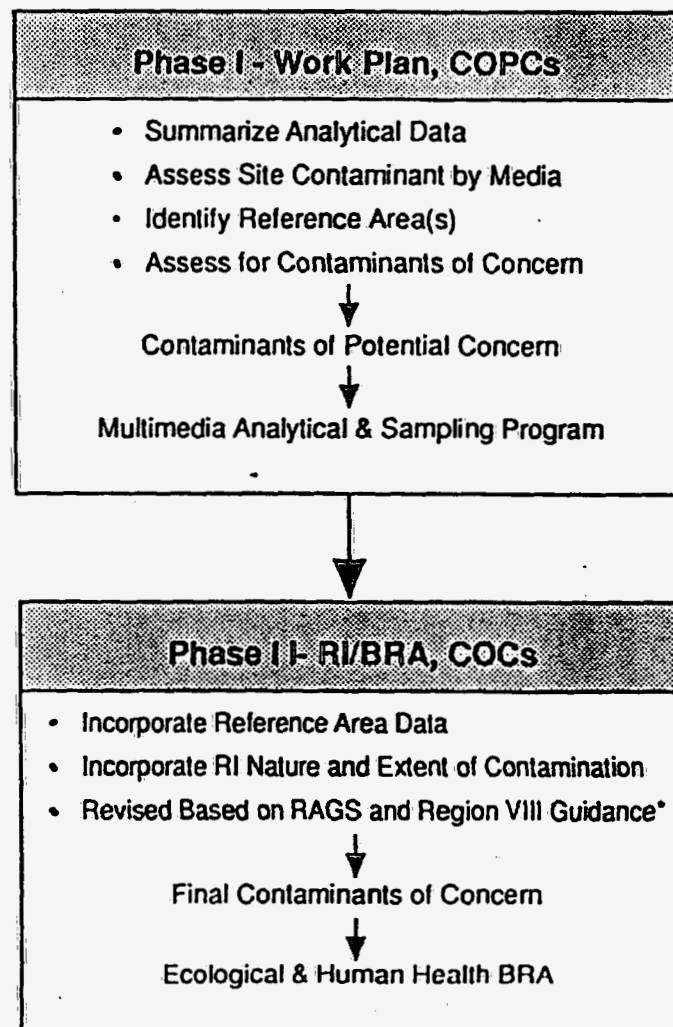
C2.0 Assessment of Chemicals of Potential Concern

C2.1 Components of the COPC Evaluation Process

C2.1.1 Introduction

Using existing data, COPCs are identified for each medium (i.e., upper flow system [UFS] ground water, surface water, etc.) by assessing two controlling considerations:

1. Are reported compounds representative of Monticello Mill Tailings Site (MMTS) contamination?

2. Does the representative of MMTS contamination present a concern for an ecological effects, human health risk, or regulatory perspective?

Figure C-2, a derivative of Region VIII guidance (see Figure 1 in EPA 1994a), illustrates the components and general flow of the assessment. Brief descriptions of each component are presented below. Summary statistical data used in the Phase I COPC process can be found annexed to this appendix in Annex C-1 NOVEMBER SUM STATS. Several examples of this application using MMTS site data are provided later in this Section.

C2.1.2 COPC Screening Process Components - Assessment of Contamination.

The factors considered in assessing whether a compound is representative of Monticello Mill Tailings Site (MMTS) contamination are discussed below.
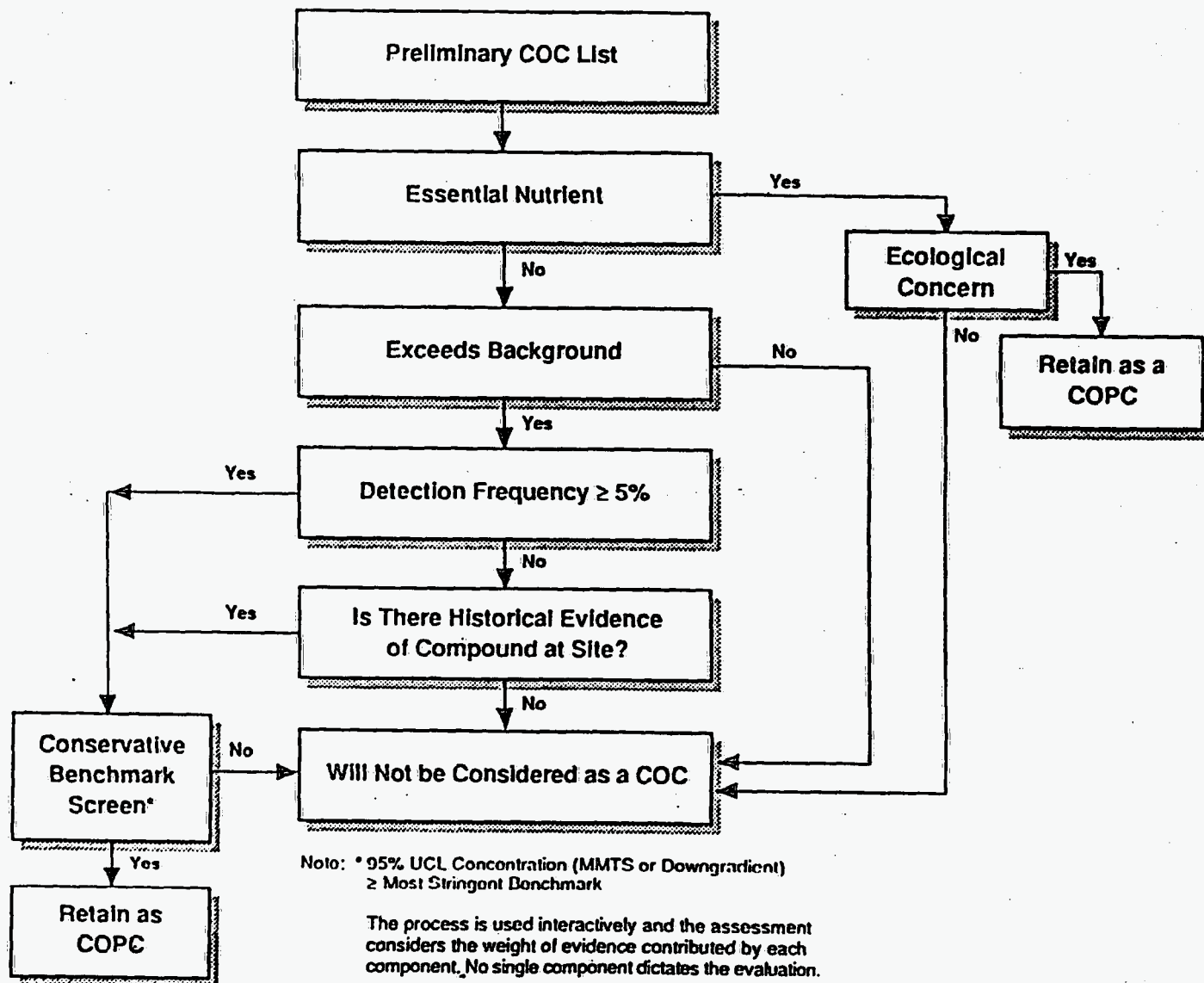
Essential Nutrients Guidance from EPA recognizes that some naturally occurring compounds are actually nutrients that are essential to human health (Section 5.9.4 EPA 1989a and Section 1, EPA 1994a). According to Region VIII Guidelines, the following compounds are candidates for elimination from the COC process if chronic daily intakes (CDI's) computed using 95 percent upper confidence limit (UCL) concentration estimates do not exceed published guidelines (See Table I EPA 1994a)

- o Calcium
- o Phosphorous
- o Iron
- o Magnesium
- o Zinc
- o Manganese
- o Potassium
- o Chloride
- o Sodium
- o Selenium
- o Molybdenum
- o Cobalt
- o Fluoride
- o Chromium III
- o Iodine
- o Copper

The CDI is computed as:

$$CDI = mg/l_{compound} * 2 \text{ liters/day} / 70 \text{ kg}$$

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Figure C-2. Screening Process


```
                    Preliminary COC List
                            │
                            ▼
                                              Yes
       Essential Nutrient ───────────────────────────┐
                            │                          │
                            │ No                       ▼        Yes
                            ▼                    Ecological ──────────┐
                                        No       Concern             │
       Exceeds Background ──────────────┐            │               │
                            │           │            │ No            ▼
                            │ Yes       │            │          Retain as a
                            ▼           │            │            COPC
               Yes                      │            │
       ◄────── Detection Frequency ≥ 5% │            │
                            │           │            │
                            │ No        │            │
                            ▼           │            │
               Yes   Is There Historical Evidence    │
       ◄────── of Compound at Site?     │            │
                            │           │            │
                            │ No        │            │
                            ▼           │            │
   Conservative      No                 │            │
   Benchmark  ──────► Will Not be Considered as a COC ◄──────┘
   Screen*                 ◄────────────┘
       │
       │ Yes
       ▼
   Retain as
   COPC
```

Note: * 95% UCL Concentration (MMTS or Downgradient)
≥ Most Stringent Benchmark

The process is used interactively and the assessment
considers the weight of evidence contributed by each
component. No single component dictates the evaluation.

Explanation

COC   Contaminant of Concern

COPC   Contaminant of Potential Concern

UCL   Upper 95% Confidence Limit

MMTS   Monticello Mill Tailings Site

Where:
- o CDI is the computed chronic daily intake in mg/kg-day
- o $mg/l_{compound}$ is the 95% upper confidence limit of the mean concentration.
- o 2 liters per day is the ingestion rate[1]
- o 70 kilograms (kg) is the typical adult body weight

If the CDI is less than the corresponding dose listed in Table I of Region VIII Guidance (EPA 1994a), the compound does not need to be considered in the risk assessment.

It is possible that an essential nutrient should not be eliminated even if the CDI is less than the guideline, such as when the estimated 95% UCL concentration exceeds an ecological life benchmark. Thus, before a compound is eliminated as an essential nutrient, its' 95 percent UCL concentration is compared to the relevant ecological concentration/toxicity benchmark as indicated on Figure C-2 and its' relationship to background is considered.

Statistical Significance EPA Guidance recommends comparisons of sample site concentrations with background as a means of identifying non-site-related chemicals; both literature references and statistical methods are discussed (Section 5.7 in EPA 1989a). Both methods were used in the Phase I process (literature comparisons will be discussed later).

The statistical approach is patterned after Region VIII guidance (See Figure 2 in EPA 1994a) by using two separate, two sample comparison techniques:

1. A parametric two sample Students' t-test was used to evaluate the difference in mean (average) concentrations between segments.

2. A non-parametric two sample Kruskal-Wallis was used to evaluate the difference in median concentrations between segments[2].

The data sets were tested for normality; however, no attempt was made to segregate the data sets and thereby guide the preference for using a parametric or nonparametric test. Instead, the lowest statistical significance value (the "p" value) from either test was used in the assessment. All "non detect" analytical reports were set to ½ the reported quantitation limit according to EPA guidance (1989a). Figure C-3 illustrates the interpretation rationale. The two sample tests, conducted in this manner are more indicative than conclusive. Care should be exercised in their interpretation, particularly when detection frequencies are less than

---

[1] For soils, the compound concentration is expressed in mg/kg and an ingestion rate of 0.000114 kg/day (114 mg/day) is used.

[2] For the simple two sample case, the Kruskal-Wallace test is equivalent to the Wilcoxon Rank Sum test suggested by Region VIII (Steel and Torrie 1980).

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Figure C-3. Interpretation Rationale of Contamination Movement
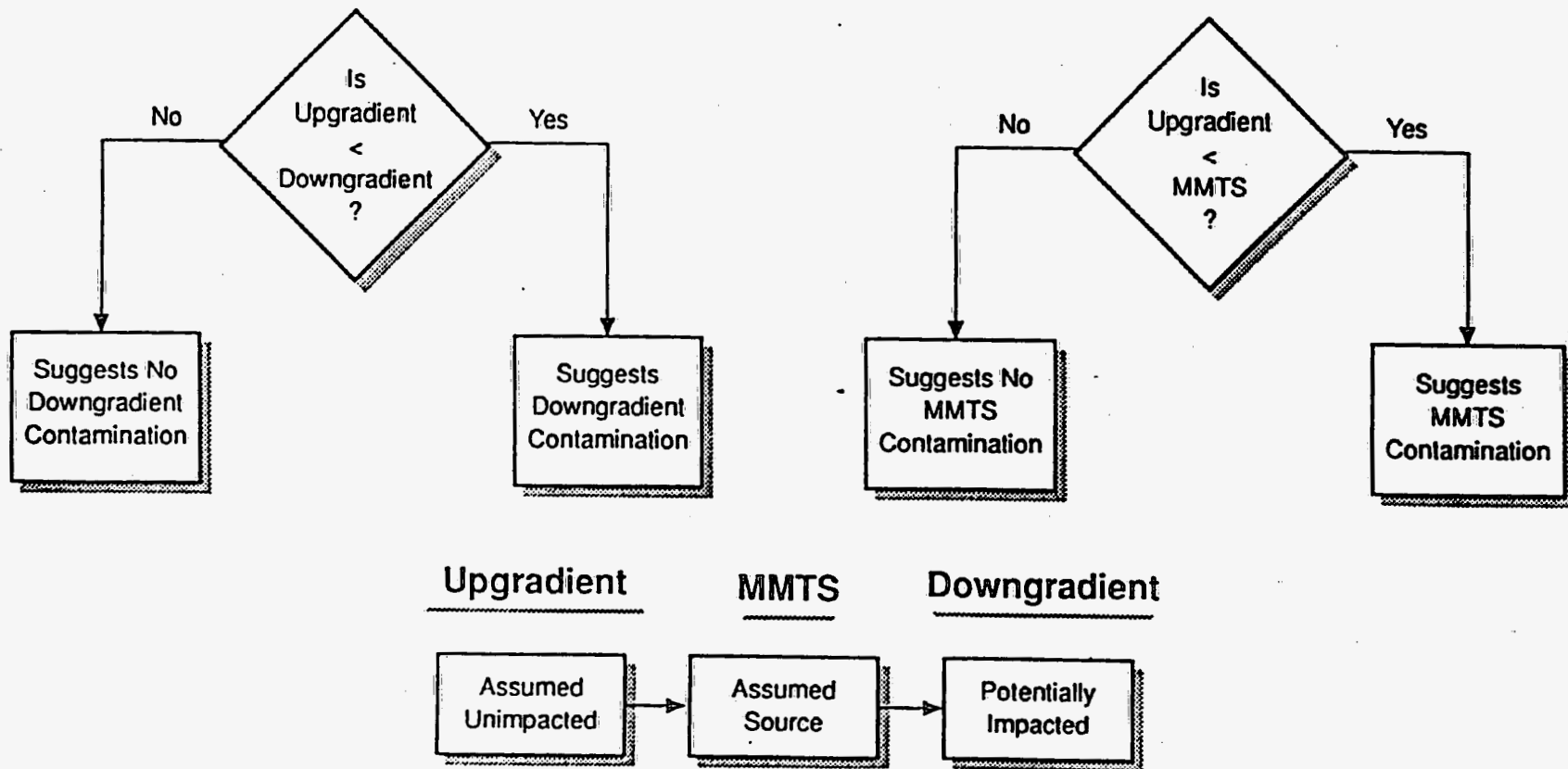
Explanation

MMTS Monticello Mill Tailings Site

- Statistical comparisons should be considered indicative, not deterministic
- "P" value guide: Significance up to 0.075 to err on the side of safety
- Confidence in comparisons diminishes with low detection frequency

60 percent. In general, tests yielding "p" values equal to or less than 0.075 were considered as indicative of significant differences between compartments[3].

Frequency of Detection The number of times a compound was detected, divided by the number of times for which it was analyzed, gives the detection frequency (i.e., the "hit rate"). Assessment of detection frequencies gives valuable input into evaluation of contamination. Consistency in detection frequency across compartments is expected for naturally occurring substances. The EPA suggests that compounds detected in less than 5 percent of the samples (based on a sample size of 20 or greater) can be deleted from the COC process (EPA 1994a).

MMTS Historical Evidence Region VIII Guidance suggests that compounds reliably associated with site activates should be considered with special qualification. Compounds generally regarded as associated with MMTS operations are identified in Table C-1.

Table C-1. *Compounds Generally Associated with Historical MMTS Activities and Processes*

Native Metals [1]	Uranium Series [2]
Arsenic	Pb-210
Copper	Ra-226
Molybdenum	Th-230
Nickel	Po-210
Uranium	Rn-222
Vanadium	U-234
Zinc	U-235
Sodium	U-238

[1] Bendix 1984.
[2] Eisenbud, 1987. Culled from the reference and assessment of the summary statistical information in Annex C1.

These compounds will be preferentially considered COPCs unless data indicates that they are not contaminants related to the MMTS, or are present at concentrations that do not present a concern.

As Table C-1 indicates, these compounds will be preferentially considered COPCs unless substantial information indicates that they are not contaminants related to the MMTS.

---

[3] EPA suggests a "p" value of 0.05 (i.e., the 5% level of significance) as indicative of significance. Increasing the threshold by 50% to 0.075 (i.e., 7.5% level of significance) errs on the side of safety by permitting a less rigorous test that differences between compartments are meaningful. An additional source of conservatism arises from taking the lowest "p" value from either test as the marker of significance.

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Contiguous Media Consideration The Site Conceptual Model indicates that ground water and surface waters are contiguous and are hydraulically connected. Thus, there is an association between adjoining UFS ground water and down gradient Montezuma Creek segments. In general, if a compound is identified as a COPC in the UFS, it will be preferentially considered as a potential COPC in the Montezuma Creek surface water system.

Literature Reference Comparisons As discussed previously, comparison of measured concentrations to background levels is an important step in the assessment of whether the observed chemical concentrations are related to MMTS activities or are attributable to nature. EPA guidance indicates that literature information from reliable sources such as the United States Geological Survey (USGS) can be used to support background comparisons used for risk assessment (EPA 1989a). Guidance further suggests that care must be exercised when using literature sources because the data contained therein could be too general. Literature information is used in the Phase I process to evaluate COPCs in the soils of Montezuma Canyon. At present, a reference location is being established to develop site-specific data to support background comparisons in Phase II of the COC process (see Figure C-1).

Literature-based comparisons in Phase I for Montezuma Canyon soils will be preferentially biased to err on the side of safety (i.e., include rather than exclude a compound as a COPC). This will be accomplished using the following criterion:

- Include as a COPC, unless the 95 percent upper confidence limit (95 percent UCL) of the mean is less than the mean of the literature data set.

In essence, this measure requires that nearly all plausible estimates of the site mean (i.e., at the upper 95 percent confidence limit) must be less than the estimated background mean in order for a compound to be eliminated as indistinguishable from background.

Visual comparison of ranges and central tendencies will also be used to assess whether reported concentrations differ from background. The data from literature sources and OU III data are summarized and displayed on summary bar graphs such as Figure C-4 for Uranium. In this example, it is evident that, based on the upward shift, uranium concentrations in Montezuma Creek Canyon (i.e., "Creek") are elevated relative to the comparison data sets.

C2.1.3 COPC Screening Process Components - Conservative Health and Regulatory Benchmark Screen

The second aspect of the COPC screening process involves assessing the impact or "concern" that a compound, identified as probable MMTS contamination, presents to human or ecological health.

EPA guidance recognizes the use of screening criteria based on health risk and/or regulatory compliance as an important aspect of the overall COPC resolution process (See Section 5.9.1 in EPA 1989a and Section 7 EPA 1994a). This step permits an assessment of the level of concern associated with compounds likely to be MMTS contaminants.
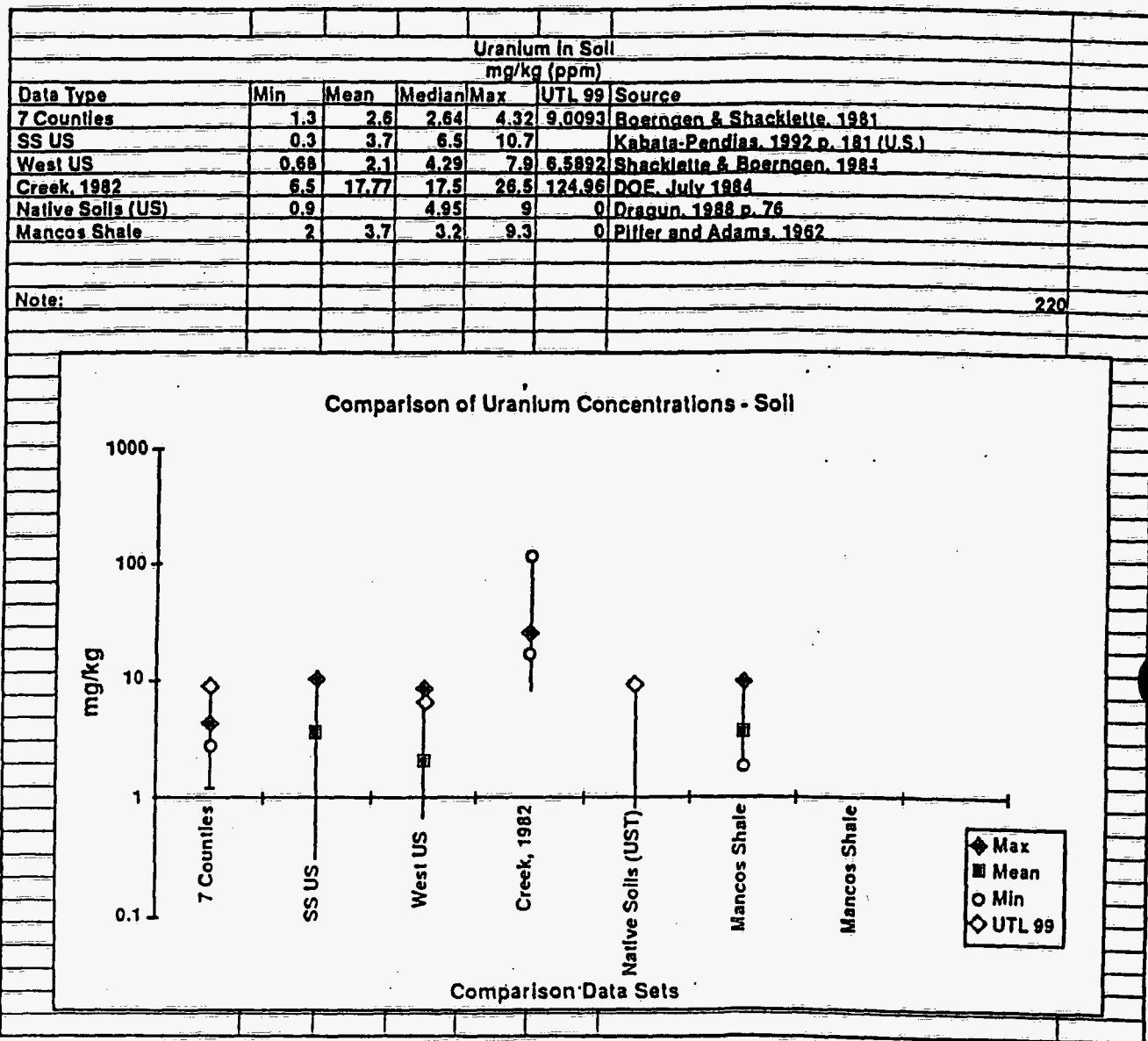
| Uranium in Soil | | | | | |
| mg/kg (ppm) | | | | | |
Data Type	Min	Mean	Median	Max	UTL 99	Source
7 Counties	1.3	2.6	2.64	4.32	9.0093	Boerngen & Shacklette, 1981
SS US	0.3	3.7	6.5	10.7		Kabata-Pendias, 1992 p. 181 (U.S.)
West US	0.68	2.1	4.29	7.9	6.5892	Shacklette & Boerngen, 1984
Creek, 1982	6.5	17.77	17.5	26.5	124.96	DOE, July 1984
Native Soils (US)	0.9		4.95	9	0	Dragun, 1988 p. 76
Mancos Shale	2	3.7	3.2	9.3	0	Pitfer and Adams, 1962
Note:						220

Figure C-4. Summary Bar Graph for Uranium

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Figure C-2 illustrates that the process contrasts measured concentrations with ecological, human health, and/or regulatory benchmarks. To be conservative and err on the side of safety in the Phase I portion of the process, the most conservative human health or ecological receptor risk or regulatory benchmark is compared to the 95 percent UCL estimated concentration. This screening step is consistent with Region VIII guidance (See Section 7 in EPA 1994a).

A brief summary of the benchmarks used for the health and regulatory concern screen follow. More details of their derivation can be found elsewhere in this WP.

Regulatory, ecological and human health benchmarks included in this category are pertinent regulatory standards and advisories, and OU III specific risk-based benchmarks that are presented elsewhere in the WP. Their sources are identified in Table C-2.

Table C-2. Regulatory and Health Risk Benchmarks Phase I - COPC Screen

Federal Safe Drinking Water Act Maximum Contaminant Levels (SDWA MCLs)
Federal Ambient Water Quality Criteria (AWQCs) for Aquatic Species
State of Utah, Standards of Quality for Waters of the State Table 2.14.1 (Human Health), Table 2.14.2 (Aquatic Wildlife)
EPA Region III, Risk-Based Concentration Tables, Fourth Quarter, 1994
Ecological Risk- Based Benchmarks for OU III, Section 4.5 of the WP
Human Health Risk- Based Benchmarks for OU III, Section 4.6 of the WP

Chemical-specific benchmarks are identified later in individual COPC analysis tables.

C2.2 Data Used for COC Process

The process presented above relies on chemical - analytical data developed from sampling and analysis conducted in the recent past. EPA Guidance suggests that data used for risk assessment purposes be of known quality so that the certainty in decisions stemming from its use can be understood by decision makers (EPA 1992b). Analytical data used in this Phase I process have been developed through consistent application of EPA and industry standard protocols; they are regarded as usable for their intended purpose of screening COPCs at this initial data evaluation stage in the WP development process. Overall, the data are regarded as appropriate for decisions at the "range" level as opposed to individual analytical report level. To compensate, the overall preference is to err on the side of safety and include compounds as COPCs rather than to omit them if fine-line judgements are involved. The effect will be to add additional conservativism to the risk analysis process through the inclusion of compounds that may not actually be MMTS contaminants.

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Guidance identifies five basic environmental quality issues frequently encountered in risk assessment (EPA 1992b). This section addresses those issues with respect to the data used for Phase I of the COC process.

<u>Data Sources</u>

Ground water, surface water, and soil data used in the Phase I COC process are those in the MMTS database with collection dates after November 1992. This data set was selected with confidence considering overall precision, accuracy, representativeness, reproducibility and completeness. Ground water, surface water, and soil reports in this period reflect consistent application of sampling practices governed by Standard Operating Procedures (SOPs), and analytical procedures comparable to the EPA's Contract Laboratory Program (CLP).

Field sampling procedures used are presented in the Remedial Investigation Feasibility Study Field Sampling Plan (Chem-Nuclear Geotech, Inc. 1992d) and Quality Assurance Project Plan (Chem-Nuclear Geotech, Inc. 1992e) and have been previously commented on by EPA and the State and comments resolved by DOE. Analytical procedures used by the GJPO Analytical Laboratory are included in the internal documents Analytical Chemistry Laboratory Administrative Plan and Quality Control Procedures, (Rust Geotech [undated]b), Analytical Chemistry Laboratory, Data Management Procedures (Rust Geotech[undated]c), Analytical Chemistry Laboratory Handbook of Analytical and Sample-Preparation Methods, Vols. I, II and III, Grand Junction, Colorado, (Rust Geotech [undated]a) and have been issued with updates to the regulatory agencies.

Literature sources used in this assessment, in order of specificity to OU III and their order of preference include:

1. <u>Chemical Analysis of Soils and Other Surficial Materials in the Conterminous United States</u>, USGS Open-File Report 81-197, Boerngen and Shacklette, 1981. From this report, a data set was selected to represent soils and surficial materials for comparison with information developed at OU III. Data from seven counties located in southeastern Utah and southwestern Colorado were chosen; they are identified as the Seven Counties data set in Table C-3.

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Table C-3. The Seven Counties Data Set

County	No. Samples
Grand, UT	3
San Juan, UT	2
Wayne, UT	2
Mesa, CO	3
Montezuma, CO	2
Montrose, CO	3
San Miguel, CO	2

Source: Boerngen and Schacklette, 1981

According to the authors, "...sampling sites were selected if possible, to represent surficial materials that were altered very little from their natural condition and supported native or cultivated plants suitable for sampling". Analytical procedures included emission spectrographic, atomic adsorption, X-ray fluorescence spectrometry, and neutron activation. These data are probably comparable to CLP analytical level III quality, though validation protocols are not documented. In general, USGS data are reliable and useable for semi-quantitative comparisons.

2. Element Concentrations in Soils and Other Surficial Materials of the Conterminous Unites States, United States Geological Survey Professional Paper No. 1270 (Schacklett and Boerngen 1984). In this work, the authors refined, summarized, and updated their 1981 work. The main distinction in this work is the summarization into western and eastern portion of the U.S. For this application, only the western U.S. data was used (referenced later as "Western US"). The data is reported as ranges with means and standard deviations.

3. Trace Elements in Soils and Plants, 2nd Edition, Kabata-Pendias and Pendias, 1992, CRC Press. Though more general than the two previous references, this work does permit discrimination by broad soils types in the U.S. (e.g., shales, sandstones, limestones/dolomites, etc.,). Data is typically reported as ranges. Citations from this reference will be designated as "US Soils".

4. The Soil Chemistry of Hazardous Materials, Hazardous Materials Control Research Institute, Dragun, 1988. This reference is general. Ranges for native soils concentrations are cited as "Typical Range" and "Extreme Limits". Only typical range information was used and it is so referenced.

5. Other sources such as USGS open file reports were also employed where appropriate. Several of these reference concentrations in the Slick Rock district, the Dakota Sandstone, and the Montezuma Canyon area which are all local formations.

Sources of literature references used in the process include;

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Detection Limits

Detection limits are an important consideration when assessing the useability of data. To be useful, sample detection limits (or sample quantitation limits, [SQLs]) should be within the range corresponding to the comparison reference. In the case of comparisons to background, it is important that site measurements are sensitive enough to detect concentrations in the background range; for comparisons to benchmarks (e.g., risk, regulatory, etc.,) it is important that SQL's and benchmarks are comparable. Consistency of SQL's over time is also an important consideration.

A review of SQL's (shown as "Range of Detected Concentrations") from the data summary in Annex C-1 demonstrates a comprehension of the need for reliable reporting of SQLs. The COPC analysis table includes SQLs to promote comparison with benchmarks and background data. Overall, SQL's are adequate and meet, or exceed, method detection limits (MDLs). SQL variability, as indicated by the range, is normal for the matrices and methods used (e.g., Pb in surface water SQLs range from 2 to 5 ug/l). For trace metals, SQL's near 1 part per billion are routinely attained for aqueous samples (1 ug/l) which is on par with EPA CLP performance. Similar observations apply to radionuclide activity detection limits (e.g., Ra-226 in surface water activity quantitation limits range from 0.04 to 0.58 pCi/l). Review of the available soils data base indicates similar SQL performance.

Qualified Data

Qualified data are the rule rather than exception in environmental analysis at the trace concentration level and such data must be used appropriately. According to EPA, "data are almost always useable in the risk assessment process, as long as the uncertainty in the data and its impact on the level of confidence of the risk assessment are thoroughly explained" (EPA 1992b). Laboratory data are often received with quality control review codes qualifiers affixed. For the Phase I COPC assessment, only those data qualified as rejected by the laboratory quality control-validation officer were omitted from the data base. This was done out of respect for the overall confidence in the post-November 1992 data set coupled with the need for culling as much reliable data as possible for the Phase I assessment[4]. The result of using a robust data base for the Phase I assessment is to increase overall confidence in the analysis by including as much analytical data as possible.

Background Samples

Analytical data reported near SQLs and sample reports with affixed qualifiers tend to complicate their use in making background comparisons. Up gradient (i.e., background) data were collected under the same quality control regime as site data and therefore are directly comparable. Literature data are regarded as of comparable quality, however, owing to the lack of supporting quality control documentation, they are somewhat less reliable. Again, any

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[4] In effect, the analytical reports are taken at face value with the exception of non-detect reports for which surrogates values at 1/2 the SQL were substituted.

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limitation associated with this uncertainty is compensated for by the numerous "errs on the side of safety" built into the Phase I process.

<u>Consistency</u>

Overall, the data used in the Phase I COPC process are very consistent. This stems from the consistent application of sampling practices governed by Standard Operating Procedures (SOPs), and analytical procedures comparable to the EPA's Contract Laboratory Program (CLP) since November 1992.

2.3 Implementation of the Phase I Work Plan Interactive COPC Process

This section presents the findings of the COPC process as discussed in the previous sections. The presentation proceeds by media with the use of analysis tables and illustrations, as appropriate. Pertinent observations and clarifying text are provided as necessary.

2.3.1 Upper Flow System - Ground Water

Table C-4 summarizes the analysis using the analytical components discussed above. The Table is configured to reflect the two step process and is organized as follows:

Step 1 - Assessment of Contamination and Affected Segments.

Step 2 - Assessment of Health and Regulatory Benchmark Screens.

Table C-4 is further segregated into those compounds that occur on Table 1 of the Ecological Risk Assessment Concept paper (the page covering Aluminum through Th-230) and additional candidate compounds that are reported in the OU III monitoring data base (Calcium through U-238). The analysis generally follows Figure C-2; to facilitate interpretation, a brief overview of Table C-4 is provided. Notes provided on the table furnish clarifications.

<u>Step 1 - Assessment of Contamination and Affected Segments</u>

o Candidate COPCs are listed down the 1st column.

o The **Essential Nutrient Comparison** is reported in the next three columns. As indicated, cobalt has a Region VIII guideline of 0.06 (mg/kg-day) and a computed Intake (i.e., CDI) of 0.001 mg/kg-day (using the 95% UCL concentration estimate). In this case, cobalt is provisionally deleted from the COPC unless other considerations such as exceedance of an ecological benchmark or elevation above background signify need for inclusion.

o The **Background Comparisons** consideration is addressed in the next six columns. Mean concentrations for each segment (or reach) from the summary statistics provided in

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Annex C-1 are displayed in the columns headed "Mean Concentrations". In the case of arsenic the following average concentrations are observed:

Up gradient   2.0 mg/l
MMTS   76.1 mg/l
Down gradient   14.1 mg/l

This low - high - mid range pattern is consistent with the premise of MMTS contamination.

Notable are the NA (Not Applicable) designations such as for beryllium and cadmium. In these instances, the detection frequency consideration indicates that these compounds have not been detected frequently enough to be considered as COPCs (see Detection Frequency).

In the next two columns, results of the two sample statistical tests are presented. The hypotheses are:

   - Is up gradient significantly less than background?
   - Is up gradient significantly less than MMTS?

An affirmative finding is suggestive that concentrations in segment or reach in question are significantly higher than up gradient. In the case of arsenic, "p" values of 0.003 and 0.0001 indicate that concentrations of arsenic are significantly higher in the down gradient and MMTS segments than in the up gradient (i.e., background). This is indicated by the "Y" designation. In some cases, statistical significance is indicated by the "p" value, however, the hypothesis tested (is up gradient less than down gradient?) is reversed. For example, in the case of barium, up gradient mean concentrations are statistically *higher* than MMTS mean concentrations.

An overall weight of evidence finding is presented in the column headed "Exceeds Background? Affected Segment(s)". In the arsenic case, the weight of evidence suggests that arsenic is an Upper Flow System (UFS) contaminant resulting from MMTS activities in both the MMTS and down gradient compartments (indicated as Down for brevity).

o   Quantitation limits are listed in the next column. This information supports conclusions drawn from the analysis. In general, quantitation limits should be comparable to the ecological, human health and regulatory benchmarks (discussed previously, Section 2.2).

o   The next seven columns detail detection frequency information for the three segments. Once again following Arsenic; detection frequencies of 24 percent, 75 percent, and 60 percent are indicated in the up gradient, MMTS, and down gradient segments, respectively. The greater than 5percent column addresses the 5 percent detection limit consideration by assessing whether the *combined detection rate in the MMTS and down gradient segments* exceeds 5 percent. In the case of arsenic, the combined detection frequency is 68 percent; beryllium, on the other hand, has a combined detection frequency of only one report in 52 samples (2 percent).

Step 1, Assessment of Contamination and Affected Segments — **Toxicity/Concentration and Regulatory Standards Screen**

	Essential Nutrient Region VIII Guideline (mg/kg-day)	Computed 95% UCL Intake (mg/kg-day)	Delete as Nutrient	Mean Conc. Up Gradient	Mean Conc. MMTS	Mean Conc. Down Gradient	Two Sample P-Value Up<Down	Up<MMTS	Exceeds Background? Affected Segment(s) Yes (MMTS)	Range of Quantitation Limits ug/l or pCi/l	Up Gradient Det/Samp	%	Mill Site (MMTS) Det/Samp	%	Downgradient Det/Samp	%	Greater or Equal to 5%	Historical Evidence # Note	Step 1 Findings BOLD Candidate @ Note	MMTS or Down Gr 95% UCL	Most Stringent Human Benchmark	Ref	COPC Yes/No	Summary of COPC Finding
Aluminum	NA	NA	No	990.8	1332.0	3039.0	N (0.0001)	Y (0.01)	Yes (MMTS)	9 to 29	17/17	100%	40/43	93%	C.6285714	63%	Yes	No	Aluminum	21923.2			Yes	Exceeds Background, Exceeds Benchmark
Antimony	NA	NA	No	1.0	28.9	0.7	N (0.123)		Yes (MMTS)	1	5/11	45%	4/29	14%	5/23	22%	Yes	No	Antimony	217.8	6.00	a	Yes	Exceeds Background, Exceeds Benchmark
Arsenic	NA	NA	No	2.0	76.1	14.1	Y (0.003)	Y(0.0001)	Yes (MMTS,Down)	2 to 4	4/17	24%	33/44	75%	21/35	60%	Yes	Yes	Arsenic	360.6	0.038 to 3.8	c	Yes	Exceeds Background, Historical, Exceeds Benchmark
Barium	NA	NA	No	66.9	53.1	97.1	N (0.011)	N (0.026)	No	NS	17/17	100%	44/44	100%	35/35	100%	Yes	No	Barium	485.0	1000.00	b	No	Does Not Exceed Background
Beryllium	NA	NA	No	NA	NA	NA	NA*	NA*	No *	1	1/11	9%	0/29	0%	1/23	4%	No	No	Beryllium	2.2	0.016 to 1.6	c	No	Does Not Exceed Background, < 5% Detect
Cadmium	NA	NA	No	NA	NA	NA	NA*	NA*	No *	1	0/17	0%	2/44	5%	1/35	3%	No	No	Cadmium	1.3	5.00	a	No	Does Not Exceed Background, < 5% Detect
Chromium	1	0.001	Yes	3.0	3.6	4.4	N (0.312)	N (0.891)	No	3 to 6	4/17	24%	12/44	27%	4/35	11%	Yes	No	Chromium	17.5	50.00	b	No	Essential Nutrient, Does Not Exceed Background
Cobalt	0.06	0.001	Yes	NA	7.9	8.7	N (0.542)	N (0.249)	No	6 to 10	0/5	0%	4/14	29%	1/12	8%	Yes	No	Cobalt	36.2	2200.00	d	No	Essential Nutrient, Does Not Exceed Background
Copper	0.037	0.005	Yes	2.1	30.4	8.9	N (0.337)	N (0.303)	No	2 to 5	2/17	12%	0.2954545	30%	9/35	26%	Yes	Yes	Copper	175.8	1300.00	b	No	Essential Nutrient, Does Not Exceed Background
Iron	0.26	0.958	No	1402.0	1946.6	4811.9	N (0.001)	N (0.383)	No	19	17/17	100%	43/44	98%	31/35	89%	Yes	No	Iron	33515.6	-		No	Does Not Exceed Background
Lead	NA	NA	No	2.4	4.6	3.9	N (0.044)	N (0.509)	No	1	9/17	53%	17/44	39%	10/35	29%	Yes	No	Lead	20.5	50.00	b	No	Does Not Exceed Background
Manganese	0.005	0.414	No	98.2	4118.7	765.3	Y (0.0008)	Y (0.0001)	Yes (MMTS,Down)	1	17/17	100%	43/43	100%	35/35	100%	Yes	No	Manganese	14491.9	180.00	d	Yes	Exceeds Background, Exceeds Benchmark
Mercury	NA	NA	No	NA	NA	NA	NA*	NA*	No *	0.1	0/11	0%	0/29	0%	0/23	0%	No	No	Mercury	ND	2.00	a,b	No	Does Not Exceed Background, < 5% Detect
Molybdenum	0.005	0.050	No	5.6	139.3	457.9	Y (0.0001)	Y (0.0001)	Yes (MMTS,Down)	1 to 27	9/17	53%	40/44	91%	31/35	89%	Yes	Yes	Molybdenum	1765.4	180.00	d	Yes	Exceeds Background, Historical, Exceeds Benchmark
Nickel	NA	NA	No	5.0	14.0	9.5	N (0.185)	Y (0.0007)	Yes (MMTS,Down)	6 to 14	0/17	0%	23/44	52%	6/35	17%	Yes	Yes	Nickel	47.4	100.00	a	No	Exceeds Background, Does Not Exceed Benchmark
Nitrate	NA	NA	No	3863.8	38338.2	14052.8	N (0.104)	N (0.818)	No	10	11/11	100%	29/29	100%	22/23	76%	Yes	No	Nitrate	41546.3	44000.00	a*	No	Does Not Exceed Background
Selenium	0.005	0.0053	No	2.8	30.9	15.6	Y (0.0002)	Y (0.0096)	Yes (MMTS,Down)	2 to 15	8/17	47%	32/44	73%	29/35	83%	Yes	No	Selenium	184.5	50.00	b	Yes	Exceeds Background, Exceeds Benchmark
Silver	NA	NA	No	NA	NA	NA	NA*	NA*	No *	1 to 7	0/17	0%	2/44	5%	0/35	0%	No	No	Silver	3.6	50.00	b	No	Does Not Exceed Background, < 5% Detect
Sulfate	NA	NA	No	545700.0	295117	789266.7	N (0.086)	Y (0.0003)	Yes (MMTS)	NS	17/17	100%	44/44	100%	35/35	100%	Yes	No	Sulfate	978227.9			Yes	Exceeds Background, No Benchmark
Thallium	NA	NA	No	NA	NA	NA	NA*	NA*	No *	1 to 2	0/17	0%	3/43	7%	1/35	3%	Yes	No	Thallium	0.8	3.00	d	No	Does Not Exceed Background, < 5% Detect
Tin	NA	NA	No	NA	NA	NA				NS	MONITORING DATA							No	Tin		22000.00	d		No Information to Base Determination
Uranium	NA	NA	No	4.9	2072.3	816.7	Y (0.0001)	Y (0.0001)	Yes (MMTS,Down)	1	17/17	100%	44/44	100%	34/35	97%	Yes	Yes	Uranium	6490.8	11.00	e	Yes	Exceeds Background, Historical, Exceeds Benchmark
Vanadium	NA	NA	No	3.4	13403.2	348.2	Y (0.0012)	Y (0.0001)	Yes (MMTS,Down)	4 to 8	3/17	18%	33/44	75%	22/35	63%	Yes	Yes	Vanadium	104737.3	260.00	d	Yes	Exceeds Background, Historical, Exceeds Benchmark
Zinc	0.3	0.003	Yes	15.2	18.4	22.1	N (0.294)	N (0.907)	No	6 to 7	14/17	82%	39/44	89%	30/35	86%	Yes	Yes	Zinc	109.6	11000.00	d	No	Essential Nutrient, Does Not Exceed Background
Pb-210	NA	NA	No	NA	14.1	6.4	NA*	NA*	No	2	0/15	0%	20/36	56%	19/29	66%	Yes	Yes	Pb-210	67.5	0.07 to 7	e	Yes	Exceeds Background, Historical, Exceeds Benchmark
Ra-226	NA	NA	No	0.2	2.1	0.1	N (0.118)	Y (0.0057)	Yes (MMTS)	0.06 to 0.55	8/17	47%	32/44	73%	13/35	37%	Yes	Yes	Ra-226	10.1	0.4 to 40	e	Yes	Exceeds Background, Historical, Exceeds Benchmark
Th-230	NA	NA	No	0.1	0.3	0.4	Y (0.0001)	Y (0.0011)	Yes (MMTS,Down)	0.05 to .3	3/17	18%	5/43	12%	4/35	11%	Yes	Yes	Th-230	1.6	4 to 400	e	No	Exceeds Background, Historical, Does Not Exceed Benchmark

Boundaries
Up Gradient: Wells Hydrologically Up Gradient of the MMTS
On-Site Wells: Located East of Highway 191 and West of the Eastern Boundary of the MMTS
Down-Gradient: Wells Located East of the Eastern Boundary of the MMTS

Benchmark References
Human
a) SDWA- MCL
b) Utah Water Quality Standard
c) USEPA, Region III RBC, 1E-6 to 1E-4 Risk Range for Tap Water
d) USEPA, Region III RBC, 0.1 HQ
e) Computed 1E-6 to 1E- 4 Risk Range for Long Term Ingestion
f) Computed HQ = 0.1
g) Site Specific
a*) Derived from SDWA-MCL for total nitrogen (secondary standard)
Benchmarks Are An Assembly of Potential Criteria And Limits; Not ARARs

Note: Historical Evidence, Yes = Characteristic of Ore From the Salt Wash Member of the Morrison Formation (USDOE, 1984) and/or Likely Related Radionuclides From the Uranium Series
NS: Not Specified
@ Note: Step 1 Findings Identify All Remaining Candidate Compounds for the Toxicity/Concentration and Regulatory Screen (Step 2)
NA*: Due to No, or Limited Number of, Detections, Statistical Comparisons are Not Applicable
No*: A finding of "Does Not Exceed Background" Based on No Appreciable Detection Frequency. Statistical Comparisons are Not Valid. See Section on Detection Frequency
*: 5% Based On Combined MMTS and Downgradient Sample Sizes
"P" Value Note: Statistical Comparisons Should Be Considered As Indicative, Not Deterministic. Low Detection Rates (<50%) Can Give Misleading Indications
Yes!: Benchmark Not Available. Include as COPC to Err on the Side of Safety

Toxicity/Concentration and Regulatory Standards Screen

	Essential Nutrient			Background Comparison						Detection Frequency							Historical Evidence	Step 1 Findings				Finding		
	Region VIII Guideline (mg/kg-day)	Computed 95% UCL Intake (mg/kg-day)	Delete as Nutrient	Mean Concentrations, ug/l or pCi/l			Two Sample "P-Value" (Note)		Exceeds Background? (Affected Segment(s))	Range of Quantitation Limits ug/l or pCi/l	Up Gradient Det/Samp.	%	MI Site (MMTS) Det/Samp.	%	Downgradient Det/Samp.	%	Greater or Equal to 5%	@ Note	TBOCD Candidate @ Note	MMTS or Down Gr ug/l or pCi/l 95% UCL	Most Stringent Benchmark Human Benchmark	Ref	COPC	Summary of COPC Finding
				Up Gradient	MMTS	Down Gradient	Up < Down	Up < MMTS																
Calcium	14	17,390	No	263911.1	2.9E+05	262058.3	N (0.855)	N (0.562)	No	NR	17/17	100%	44/44	100%	35/35	100%	Yes	No	Calcium	808658.0	-		No	Does Not Exceed Background
Boron	NA	NA	No	59.9	159.9	131.5	Y (0.0001)	Y (0.0001)	Yes (MMTS, Down)	42	17/17	100%	43/43	100%	35/35	100%	Yes	No	Boron	391.1	3300.00	d	No	Exceeds Background, No Benchmark
Cyanide	NA	NA	No	3.3	3.6	4.4	N (0.130)	N (0.727)	No	4 to 10	0/11	0%	1/26	4%	4/23	17%	Yes	No	Cyanide	7.6	730.00	d	No	Does Not Exceed Background
Sodium	NA	NA	No	38890.0	4.7E+05	212311.1	N (0.0050)	Y (0.0001)	Yes (MMTS)	NR	17/17	100%	44/44	100%	35/35	100%	Yes	Yes	Sodium	495208.3	-		Yes	Exceeds Background, No Benchmark
Gross Alpha	NA	NA	No	15.2	1524.4	586.8	Y (0.001)	Y (0.001)	Yes (MMTS,Down)	12.1 to 52	0/17	0%	34/43	79%	34/35	97%	Yes	Yes	Gross Alpha	4689.6	15 to 1500	a,b	Yes	Exceeds Background, Historical, Exceeds Benchmark
Gross Beta	NA	NA	No	12.2	494.3	220.4	Y (0.0001)	Y (0.0001)	Yes (MMTS,Down)	7 to 52	0/17	0%	30/43	70%	34/35	97%	Yes	Yes	Gross Beta	1412.7	50 to 5000	a,b	Yes	Exceeds Background, Historical, Exceeds Benchmark
Po-210	NA	NA	No	NA	2.5	0.4	NA *	NA *	No	0.08 to 1.01	0/17	0%	13/43	30%	2/35	6%	Yes	Yes	Po-210	16.7	.32 to 32	e	No	Does Not Exceed Background
Rn-222	NA	NA	No	700.4	4302.1	1577.7	Y (0.005)	Y (0.0002)	Yes (MMTS,Down)	78	18/18	100%	43/43	100%	35/35	100%	Yes	Yes	Rn-222	21252.6	3 to 300	e	Yes	Exceeds Background, Historical, Exceeds Benchmark
U-234	NA	NA	No	7.3	686.5	272.2	Y (0.0001)	Y (0.0001)	Yes (MMTS,Down)	0.04	16/17	94%	43/43	100%	35/35	100%	Yes	Yes	U-234	2142.9	3 to 300	e	Yes	Exceeds Background, Historical, Exceeds Benchmark
U-235	NA	NA	No	0.1	45.3	13.3	Y (0.0001)	Y (0.0001)	Yes (MMTS,Down)	0.07 to 0.29	1/12	8%	25/29	86%	19/23	83%	Yes	Yes	U-235	143.1	3 to 300	e	Yes	Exceeds Background, Historical, Exceeds Benchmark
U-238	NA	NA	No	5.9	700.1	276.5	Y (0.0001)	Y (0.0001)	Yes (MMTS,Down)	0.26	16/17	94%	43/43	100%	35/35	100%	Yes	Yes	U-238	2194.8	3 to 300	e	Yes	Exceeds Background, Historical, Exceeds Benchmark

Boundaries
Up Gradient: Wells Hydrologically Up Gradient of the MMTS
On-Site Wells: Located East of Highway 191 and West of the Eastern Boundary of the MMTS
Down-Gradient: Wells Located East of the Eastern Boundary of the MMTS

Benchmark References
Human
a) SDWA- MCL
b) Utah Water Quality Standard
c) USEPA, Region III RBC, 1E-6 to 1E-4 Risk Range for Tap Water
USEPA, Region III RBC, 0.1 HQ
Computed 1E-6 to 1E-4 Risk Range for Long Term Ingestion
Computed HQ = 0.1
g) Site Specific
a") Derived from SDWA-MCL for total nitrogen (secondary standard)
Benchmarks Are An Assembly of Potential Criteria And Limits; Not ARARs

@ Note: Historical Evidence, Yes = Characteristic of Ore From the Salt Wash Member of the Morrison Formation (USDOE, 1964) and/or Likely Related Radionuclides From the Uranium Series
NS: Not Specified
@ Note: Step 1 Findings Identify All Remaining Candidate Compounds for the Toxicity/Concentration and Regulatory Screen (Step 2)
NA*: Due to No, or Limited Number of, Detections, Statistical Comparisons are Not Applicable
No*: A finding of "Does Not Exceed Background" Based on No Appreciable Detection Frequency. Statistical Comparisons are Not Valid. See Section on Detection Frequency
*: 5% Based On Combined MMTS and Downgradient Sample Sizes
"P" Value Note: Statistical Comparisons Should Be Considered As Indicative, Not Determinstic. Low Detection Rates (<80%) Can Give Misleading Indications
Yes!: Benchmark Not Available. Include as COPC to Err on the Side of Safety

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o The final column in the Step 1 assessment identifies whether the compound is historically related to the MMTS process. Arsenic has been so identified while antimony has not.

Step 2 - Assessment of Human Health, Ecological and Regulatory Concern

The second step of the assessment begins with a column headed "Summary of Step 1 Findings". The weight of evidence from Step 1 results in a bold designation of contaminants considered reflective of MMTS activities.

The second step assessment is a straightforward comparison of 95 percent UCL estimated concentrations with the most stringent benchmark identified. In the case of the UFS, only human health benchmarks are presented because ground water is not considered an ecological media of concern.

As an example, arsenic is again used to illustrate the comparative process.

o Since the most conservative arsenic human health benchmark (0.038 mg/l, EPA Region III RBC for 1 C-6 chronic consumption risk[5]) is exceeded by the estimates 95 percent UCL UFS concentration (360.6 mg/l) the cell is encased, indicating an exceedance.

On the basis of this two step process, arsenic is identified a COPC because 1) the weight of evidence suggests that its' presence stems from MMTS operations, and 2) it occurs in the UFS at concentrations exceeding the most stringent benchmark of concern. Thus arsenic 1) is a contaminant, and 2) is of potential concern.

Completing this assessment for the other UFS compounds results in the following list of COPCs presented in Table C-5.

Table C-5. UFS COPCs From the Two Step Process

Aluminum	Boron
Antimony	Sodium
Arsenic	Alpha
Manganese	Beta
Molybdenum	Rn-222
Selenium	U-234
Sulfate	U-235
Tin	U-238
Elemental U	Pb-210
Vanadium	Ra-226

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[5] The 1C-6 to 1C-4 risk range is included to indicate the range of acceptable risk from the National Contingency Plan (40 CFR Part 300). In this analysis, the 1C-6 "point of departure" threshold is used to ensure conservativism, and to address EPA Region VIII guidance.

In all, twenty individual COPCs for the human health risk assessment have been identified for the UFS. A brief summary rationale for the selection or elimination of each candidate COPC is given in the last column of Table C-4.

C2.3.2 Montezuma Creek - Surface Water

The same evaluation process was applied to the surface water system. Details of the two-step evaluation are presented in Table C-6; COPCs for surface waters are identified in Table C-7.

In the surface water evaluation, both human health and ecological benchmarks are considered. It is notable that the human health benchmarks reflect the assumption of a recreational use of Montezuma Creek, as opposed to the residential use assumption applied to the ground water evaluation. Overall, this tends to make the surface water human health benchmarks less conservative than in the UFS case. Not surprising, is the emergence of ecological and regulatory benchmarks as the controlling criteria of concern.

Table C-7. SW Montezuma Creek Human Health and Ecological COPCs

Compound	Human Health	Ecological
Aluminum		X
Arsenic	X	X
Copper		X
Nitrate		X[1]
Selenium	X	X
Sulfate	X[1]	X[1]
Tin	X[1]	X[1]
Elemental U	X	
Vanadium	X	X[1]
Pb-210		X[1]
Boron	X[1]	
Sodium	X[1]	X[1]
Alpha	X	X
Beta	X	X[1]
Rn-222	X	X[1]
U-234	X	X[1]
U-235	X	X[1]
U-238	X	X[1]

[1] Benchmarks not identified currently. Retained as COPCs to err on the side of safety.

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	Essential Nutrient			Background Comparison					Detection Frequency								Historical Evidence	Step 1 Findings	MMTS or	Most Stringent Benchmark				Finding		
	Region VIII 95% UCL Int (mg/kg-day)	Computed 95% UCL Int (mg/kg-day)	Delete As Nutrient	Mean Concentrations, ug/l or pCi/l			Two Sample 'P-Value' (Note)		Exceeds Background? (Affected Reach(s))	Range of Quantitation Limits	Up Gradient Det/Samp.		Mill Site (MMTS) Det/Samp.		Downgradient Det/Samp.		Greater or Equal to 0.05 *	COPC in UFS ?	@ Note	BOLD = Down Gradient Candidate @ Note	Down Gradient ug/l or pCi/l 95% UCL	Human Benchmark	Ref.	Ecological Benchmark	Ref.	Finding COPC	Summary of COPC Finding
Aluminum	NA	NA		Up Gradient 433.0	MMTS 443.3	Down Gradient 751.5	Up < MMTS N (0.79)	Up < MMTS Y (0.06)	Yes (MMTS)	20	21/22 95%	25/25 100%		143/144 99%		Yes	Yes	No	Aluminum 2,049.3		87.0	1	Yes	Exceeds Background, Exceeds Benchmark
Antimony	NA	NA	No	0.8	0.8	0.7	N (0.18)	N (0.79)	No	1	4/13 31%	5/17 29%	37/96 39%	Yes	Yes	No	Antimony	1.7	8.0	a	30.0	2	No	Does Not Exceed Background
Arsenic	NA	NA	No	4.4	139.6	2.8	Y (0.05)	Y (0.0003)	Yes (MMTS,Down)	2 to 4	5/22 23%	18/25 72%	71/144 49%	Yes	Yes	Yes	Arsenic	650.3	37 to 3700	a	190.0	1	Yes	Exceeds Background, Historical, Exceeds Benchmark
Barium	NA	NA	No	83.8	56.1	64.4	Y (0.08)	N (0.347)	No	NS	22/22 100%	25/25 100%	144/144 100%	Yes	No	No	Barium	100.8	1,000.0	b	25,500.0	3	No	Does Not Exceed Background
Beryllium	NA	NA	No	NA	NA	NA	NA*	NA*	No*	1	0/13 0%	0/17 0%	0/96 0%	No	No	No	Beryllium	ND	4 to 400	b	5.3	2	No	Does Not Exceed Background, < 5% Detect
Cadmium	NA	NA	No	NA	NA	NA	NA*	NA*	No*	1	0/22 0%	0/25 0%	0/144 0%	No	No	No	Cadmium	ND	5.0	a	1.1	1	No	Does Not Exceed Background, < 5% Detect
Chromium	1	0.0002	Yes	2.0	NA	5.1	NA*	NA* (0.9)	No*	3 to 6	1/22 5%	0/25 0%	20/144 14%	Yes	No	No	Chromium	8.6	50.0	b	210.0	1	No	Essential Nutrient, Does Not Exceed Background
Cobalt	0.06	NA	No	4.0	NA	NA	NA*	NA*	No*	6 to 10	1/6 17%	0/9 0%	0/48 0%	No	No	No	Cobalt	ND	-	-	-		No	Does Not Exceed Background, < 5% Detect
Copper	0.037	0.001	Yes	2.0	8.4	2.1	N (0.07)	Y (0.03)	Yes (MMTS,Down)	2 to 5	1/22 5%	7/25 28%	40/144 28%	Yes	Yes	Yes	Copper	24.6	200.0	b	12.0	1	Yes	Essential Nutrient, Exceeds Ecological Benchmark
Iron	0.26	0.054	Yes	716.0	480.6	1004.8	N (0.46)	N (0.19)	No	NS	22/22 100%	25/25 100%	144/144 100%	Yes	No	No	Iron	1,883.0	-	-	1,000.0	1	No	Essential Nutrient
Lead	NA	NA	No	1.9	1.2	2.1	N (0.12)	N (0.8)	No	1	9/22 41%	8/25 32%	78/144 54%	Yes	No	No	Lead	3.8	50.0	b	3.2	1	No	Essential Nutrient, Exceeds Ecological Benchmark
Manganese	0.005	0.014	No	266.0	167.6	182.9	Y (0.0001)	Y (0.008)	Yes (MMTS,Down)	NS	22/22 100%	25/25 100%	144/144 100%	Yes	No	No	Manganese	477.5	3.9E+05	d	700,000.0	3	No	Essential Nutrient
Mercury	NA	NA	No	NA	0.1	NA	NA*	NA*	No*	0.1	0/13 0%	1/17 8%	0/96 0%	No	No	No	Mercury	NA	2.0	a,b	0.012	1	No	Does Not Exceed Background, < 5% Detect
Molybdenum	0.005	0.026	No	10.0	175.0	13.9	Y (0.0001)	Y (0.003)	Yes (MMTS,Down)	1 to 27	11/22 50%	18/25 72%	87/144 87%	Yes	Yes	Yes	Molybdenum	916.5	-		-		Yes	Essential Nutrient, No Ecological Benchmark
Nickel	0.005	NA	No	5.0	5.2	6.4	N (0.99)	N (0.59)	No	6 to 14	3/22 14%	0.08 0%	37/144 26%	Yes	Yes	Yes	Nickel	8.0	100.0	a	160.0	1	No	Does Not Exceed Background
Nitrate	NA	NA	No	4337.3	5520.5	747.0	Y (0.08)	N (0.06)	Yes (MMTS)	NS	13/13 100%	17/17 100%	96/96 100%	Yes	No	No	Nitrate	21,380.0	44,000.0	b	-		Yes	Does Not Exceed Background, No Ecological Benchmark
Selenium	0.005	0.006	No	2.2	38.0	2.3	Y (0.07)	N (0.0001)	Yes (MMTS,Down)	2 to 15	11/22 50%	23/25 92%	75/144 52%	Yes	Yes	Yes	Selenium	206.7	50.0	a	5.0	1	Yes	Exceeds Background, Exceeds Benchmark
Silver	NA	NA	No	NA	NA	NA	NA*	NA*	No*	1 to 7	0/22 0%	0/25 0%	0/144 0%	No	No	No	Silver	ND	50.0	a,b	0.12	1	No	Does Not Exceed Background, < 5% Detect
Sulfate	NA	NA	No	223611.8	6000483.3	385105.0	Y (0.004)	Y (0.0002)	Yes (MMTS,Down)	NS	22/22 100%	25/25 100%	144/144 100%	Yes	No	No	Sulfate	566,324.0	-		-		Yes	Exceeds Background
Thallium	NA	NA	No	NA	NA	NA	NA*	NA*	No*	1 to 2	0/22 0%	0/25 0%	0/144 0%	No	No	No	Thallium	ND	2.0	a	40.0	2	No	Does Not Exceed Background, < 5% Detect
Tin	NA	NA	No	NA	NA	NA				NS	entering Data							Tin						Yes	No Information to Base Determination
Uranium	NA	NA	No	19.0	652.1	93.6	Y (0.0001)	Y (0.0001)	Yes (MMTS,Down)	1	17/22 77%	25/25 100%	126/144 88%	Yes	Yes	Yes	Uranium	3,471.1	0pCi (82ug/l)	e	9,000.0	2	Yes	Exceeds Background, Historical, Exceeds Benchmark
Vanadium	NA	NA	No	9.3	3856.3	20.9	Y (0.0001)	Y (0.0001)	Yes (MMTS,Down)	4 to 9	5/22 23%	25/25 100%	90/144 63%	Yes	Yes	Yes	Vanadium	19,691.9	197,000.0	d	-		Yes	Exceeds Background, Historical, No Ecological Benchmark
Zinc	0.3	0.001	Yes	11.7	12.1	23.0	N (0.43)	N (0.52)	None	3 to 6	20/22 91%	24/25 96%	125/144 87%	Yes	No	Yes	Zinc	39.4	6,423,000.0	d	110.0	1	No	Essential Nutrient, Does Not Exceed Background
Pb-210	NA	NA	No	NA	5.5	1.2	NA*	NA*	Yes (MMTS)	2	0/22 0%	6/20 25%	20/120 17%	Yes	Yes	Yes	Pb-210	24.3	56 to 5600	-	-		Yes	Exceeds Background, Historical, No Ecological Benchmark
Ra-226	NA	NA	No	0.6	2.4	0.3	Y (0.0001)	Y (0.0001)	Yes (MMTS,Down)	0.07 to 1.2	10/22 45%	21/25 84%	104/144 72%	Yes	Yes	Yes	Ra-226	2.5	6 to 500	a,b	4.8		No	Exceeds Background, Historical, Does Not Exceed Benchmark
Th-230	NA	NA	No	0.1	0.5	0.1	NA*	NA*	Yes (MMTS,Down)	0.05 to 0.9	1/22 5%	4/25 16%	23/144 16%	Yes	Yes	Yes	Th-230	2.6	4 to 400	e	-		Yes	Exceeds Background, Historical, No Ecological Benchmark

Boundaries
Up-Gradient: Surface Water Locations Hydrologically Up Gradient of the MMTS
MMTS: Surface Water Locations East of Highway 191 and West of the Eastern Boundary of the MMTS
Down-Gradient: Surface Water Locations East of the Eastern Boundary of the MMTS

Benchmark References
Human
a) SDWA-MCL
b) Utah Water Quality Standard
c) 1E-6 Recreational Ingestion
d) HQ = 0.1 Recreational Ingestion
e) Site Specific
f) USEPA Region III RBC, 1E-6 to 1E-4 Risk Range for Tap Water (Note: Applied as a Conservative Surrogate for Screening; Montezuma Creek Exposure Scenario is Recreational, not Domestic)
g) USEPA Region III RBC, HQ = 0.1 for Tap Water (Note: Applied as a Conservative Surrogate for Screening; Montezuma Creek Exposure Scenario is Recreational, not Domestic)
h) State of Utah Standard for Agricultural Use (Stock Watering & Crop Irrigation)
Benchmarks Are An Assembly of Criteria and Limits, Not ARARs

Ecological
1) Utah Water Quality Standard
2) Lowest Observed Effect Level from Literature Source
3) Computed Based on Small Herbivor Ingestion of Water

@ Note: Historical Evidence, Yes = Characteristic of Ore From the Salt Wash Member of the Morrison Formation (USDOE, 1984) and/or Likely Related Radionuclides From the Uranium Series
NS: Not Specified
@ Note: Step 1 Findings Identify All Remaining Candidate Compounds for the Toxicity/Concentration and Regulatory Screen (Step 2)
NA*: Due to No, or Limited Number of, Detections, Statistical Comparisons are Not Applicable
No*: A Finding of "Does Not Exceed Background" Based on No Appreciable Detection Frequency. Statistical Comparisons are Not Valid. See Section on Detection Frequency
*: 5% Based on Combined MMTS and Downgradient Sample Sizes
'P' Value Note: Statistical Comparisons Should be Considered As Indicative, Not Determinstic. Low Detection Rates (< 60%) Can Give Misleading Indications
...ed: Benchmark not Available. Include as COPC to Err on the Side of Safety

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Step 1. Assessment of Contamination and Affected Reach(s)

Toxicity/Concentration & Preliminary ARAR Screen

	Essential Nutrient			Background Comparison			Two Sample "P-Value" (Note)		Exceeds Background? (Affected Reach(s))	Detection Frequency							Greater or Equal to 0.05 * Yes	COPC in UFS ? No	Historical Evidence # Note	Step 1 Findings (BOLD = Candidate @ Note)	MMTs or Down Gradient ug/l or pCi/l 95% UCL	Most Stringent Benchmark				Finding	
	Region VIII (mg/kg-day)	Computed 95% UCL Int (mg/kg-day)	Delete As Nutrient	Up Gradient	MMTS	Down Gradient	Up < Down	Up < MMTS		Range of Quantitation Limits ug/l or pCi/l	Up Gradient Det/Samp	%	Mil Site (MMTS) Det/Samp	%	Downgradient Det/Samp	%						Human Benchmark	Ref	Ecological Benchmark	Ref	COPC	Summary of COPC Finding
Boron	NA	NA	No	69.2	133.3	73.3	Y (0.009)	Y (0.0007)	Yes (MMTS,Down)	42	21/22	95%	25/25	100%	126/144	88%	Yes	No	No	Boron	394.3	-		750.0	g	Yes (H)	Exceeds Background, No Human Benchmark
Calcium	14	9.368	Yes	165292.4	202310.3	146986.1	N (0.23)	N (0.17)	No	NS	22/22	100%	25/25	100%	144/144	100%	Yes	No	No	Calcium	327,882.8	-		-		No	Essential Nutrient, Does Not Exceed Background
Cyanide	NA	NA	No	NA	NA	NA	NA*	NA*	No*	4 to 10	0/13	0%	0/17	0%	0/96	0%	No	No	No	Cyanide	ND	-		5.2		No	Does Not Exceed Background, < 5% Detect
Magnesium	5.7	1.685	Yes	29581.2	43640.0	34030.0	Y (0.002)	Y (0.0003)	Yes (MMTS,Down)	NS	22/22	100%	25/25	100%	144/144	100%	Yes	No	No	Magnesium	56,961.8	-		-		No	Essential Nutrient, Does Not Exceed Background
Sodium	NA	NA	No	81198.8	151560.0	79772.5	N (0.6)	N (0.57)	Yes (MMTS,Down)	NS	22/22	100%	25/25	100%	144/144	100%	Yes	No	No	Sodium	522,279.0	-		-		Yes (H,E)	Exceeds Background, No Human or Ecological Benchmarks
Gross Alph	NA	NA	No	20.2	369.8	68.7	Y (0.0001)	Y (0.01)	MMTS & Down	9.9 to 70	1/22	5%	0.72	72%	90/144	63%	Yes	Yes	Yes	Gross Alpha	1,825.7	15.0	a,b	15.0		Yes (H,E)	Exceeds Background, Historical, Exceeds Benchmark
Gross Beta	NA	NA	No	16.6	164.4	25.8	Y (0.0001)	Y (0 0001)	MMTS & Down	6.7 to 64	1/22	5%	9/25	36%	69/144	48%	Yes	Yes	Yes	Gross Beta	894.7	50.0	a,b	-		Yes (H)	Exceeds Background, Historical, No Ecological Benchmark
Po-210	NA	NA	No	0.1	0.2	NA	N (0.33)	NA*	No*	0.08 to 1.08	2/22	9%	1/25	4%	0/144	0%	No	Yes	Yes	Po-210	0.4	44 to 24,400		-		No	Does Not Exceed Background, < 5% Detect
Rn-222	NA	NA	No	265.4	1109.0	70.7	N (0.27)	Y (0.0001)	MMTS	36 to 129	10/22	45%	24/25	96%	66/144	46%	Yes	Yes	Yes	Rn-222	4,366.9	3 to 300	e	-		Yes (H)	Exceeds Background, Historical, No Ecological Benchmark
U-234	NA	NA	No	8.3	228.3	33.9	Y (0.0001)	Y (0.0001)	MMTS & Down	NS	22/22	100%	25/25	100%	144/144	100%	Yes	Yes	Yes	U-234	1,197.8	3 to 300	e	-		Yes (H)	Exceeds Background, Historical, No Ecological Benchmark
U-235	NA	NA	No	0.1	10.6	1.1	Y (0.0001)	Y (0.0001)	MMTS & Down	0.05 to 3.54	1/16	6%	10/16	63%	61/96	64%	Yes	Yes	Yes	U-235	50.0	3 to 300	e	- -		Yes (H)	Exceeds Background, Historical, No Ecological Benchmark
U-238	NA	NA	No	6.9	228.4	33.5	Y (0.0001)	Y (0.0001)	MMTS & Down	0.28 to .41	19/22	86%	25/25	100%	144/144	100%	Yes	Yes	Yes	U-238	1,203.3	3 to 300	e	-		Yes (H)	Exceeds Background, Historical, No Ecological Benchmark

MMTS: Surface Water Locations East of Highway 191 and West of the Eastern Boundary of the MMTS
Down-Gradient: Surface Water Locations East of the Eastern Boundary of the MMTS

Benchmark References

a) SDWA-MCL
b) Utah Water Quality Standard   Ecological:
c) 1E-6 Recreational Ingestion   3) Computed Based on Small Herbivor Ingestion of Water
d) HQ = 0.1 Recreational Ingestion
e) Site Specific
f) USEPA Region III RBC, 1E-6 to 1E-4
g) USEPA Region III RBC, HQ = 0.1 for Tap Water (Note: Applied as a Conservative Surrogate for Screening; Montezuma Creek Exposure Scenario is Recreational, not Domestic)
h) State of Utah Standard for Agricultural Use (Stock Watering & Crop Irrigation)
Benchmarks Are An Assembly of Criteria and Limits, Not ARARs

Note: Historical Evidence, Yes = Characteristic of Ore From the Salt Wash Member of the Morrison Formation (USDOE, 1984) and/or Likely Related Radionuclides From the Uranium Series

@ Note: Step 1 Findings Identify All Remaining Candidate Compounds for the Toxicity/Concentration and Regulatory Screen (Step 2)
NA*: Due to No, or Limited Number of, Detections, Statistical Comparisons are Not Applicable
No*: A Finding of "Does Not Exceed Background" Based on No Appreciable Detection Frequency. Statistical Comparisons are Not Valid. See Section on Detection Frequency
*: 5% Based on Combined MMTS and Downgradient Sample Sizes
"P" Value Note: Statistical Comparisons Should be Considered As Indicative, Not Deterministic. Low Detection Rates (< 80%) Can Give Misleading Indications
Yes!: Benchmark not Available. Include as COPC to Err on the Side of Safety

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As indicated eighteen individual COPCs, reflecting both human and ecological concerns have been identified for the Montezuma Creek. A brief summary rationale of the selection or elimination of each candidate COPC is given in the last column on Table C-6. It is notable that in several instances, benchmarks were not available to promote the second step. In these instances, the compound was retained to err on the side of safety. It is possible that at Phase II, when information from the reference area has been developed and investigation of the toxic potentials has been conducted, Table C-7 may be refined.

C2.3.3 Montezuma Canyon Soils - Surface and Subsurface

Analytical results from the confirmation sampling of soils in Montezuma Creek have been subjected to the same analysis process. Several distinctions from the UFS and Montezuma Creek surface water systems, however, are apparent when viewing the analysis tables (Tables C-8 and C-9).

1. The principal comparison to background involves the "Seven Counties" reference data set discussed previously.

2. The confirmation sampling of soils in the Montezuma Creek data set was directed toward substantiating prior knowledge, not long-term monitoring, as in the case of the UFS and surface waters. This probably introduces a bias to overestimate the overall concentrations of compounds in the Montezuma Canyon soils.

3. Not all data from the confirmation sampling have been incorporated in this assessment.

4. The soils data base is generally smaller.

Overall, these points indicate that the Phase I process, as applied to the soils, does not have the same level of confidence as does the UFS and Montezuma Creek surface water system. To compensate, a stringent background comparison hurdle will be applied[6]. If visual contrast from the bar graphs are employed, they must convincingly demonstrate no discernable difference between Canyon Soils and background data sets.

For reorientation, a brief survey of the Phase I process, applied to Montezuma Canyon soils, follows.

Step 1 - Assessment of Contamination

Essential Nutrient This step is the same as for the UFS and Montezuma Creek surface water system.

Background Comparisons Means are compared and the ratio of the Montezuma Canyon and seven counties data sets are computed. A metric ratio greater than 1.0 indicates that the Montezuma Canyon mean is higher (e.g., Arsenic 7.36 mg/kg / 6.7 mg/kg = 1.11).

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[6] Nearly all plausible estimates of the site mean (95% upper confidence limit) must be less than the estimated background mean in order for a compound to be eliminated as indistinguishable from background.

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The next comparison involves 95 percent UCL estimate of the mean from Montezuma Canyon and the seven counties mean. A metric ratio greater than 1.0 indicates that the 95 percent UCL estimate of the Montezuma Canyon mean is higher than the 7 counties mean (e.g., Arsenic 13.6 mg/kg / 6.7 mg/kg = 2.05).

A summary of the visual interpretation of the Montezuma Canyon data and other relevant data sets is presented as supporting to the comparisons and metric ratios. These observations are included on the second page, owing to space limitations.

Detection Frequency

This step is the same as for the UFS and Montezuma Creek surface water systems. Only the Montezuma Creek soils data is presented and the 5 percent detection frequency criterion is applied.

Historical Evidence

This step is the same as for the UFS and Montezuma Creek surface water systems.

Step 2 - Assessment of Human Health and Ecological Concerns

Once again, this step is the same as for the UFS and Montezuma Creek surface water systems. Soils benchmarks are employed instead of aqueous measures.

C2.3.3.1 Montezuma Creek Soils Less Than Six Inches

Table C-8 illustrates the analysis for the Montezuma Creek soils collected from a depth of less than six inches (e.g., surface materials). The findings are presented in Table C-10.

Inspection of Table C-10 reveals that 11 COPCs have been identified in the upper six inch portion of the Montezuma Creek soils. It is evident that the paucity of benchmarks and sampling data result in many compounds being retained simply through default.

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Step 1. Assessment of Contamination

	Essential Nutrient		Delete as Nutrient	Background Comparisons						Detection Frequency		Greater or Equal to 5%	Observation from Visual Presentation (see attached data summaries and bar graphs)	Exceeds B.G.	Historical Evidence # Note	Step 1 Findings BOLD= Candidate @ Note	Montezuma Canyon 95% UCL mg/kg or pCi/g	Most Stringent Benchmarks				COPC	Summary of COPC Finding	Residential (Soils) mg/kg (a)	Recreational (Sediments) mg/kg (a)	Region III RBC's mg/kg
	Region VIII Guideline (mg/kg-day)	Computed 95% UCL Intake (mg/kg-day)		Montezuma Canyon Mean	7 Counties Mean	Canyon/ 7 County Ratio	Montezuma Canyon 95% UCL	7 Counties Mean	Montezuma Canyon 95% UCL /7 Counties Mean Ratio	Del/Samp %								Human Health	Ref.	Ecological	Ref.					
Aluminum	NA	NA	No	9,503.1	53,529.0	0.18	11,511.8	53529.0	0.22	16/16 100%	No	Comparable to, & enveloped within, regional and national values. No apparent elevations.	No	No	Aluminum	11,511.76	7,800.0	a	-	-	No	Does Not Exceed Background	110.00	267,400.00	78,000.00 31.00
Antimony	NA	NA	No	ND	0.8	NA	6.2	0.8	NA	0/16 0%	Yes	Not detected on Canyon samples.	No	No	Antimony	6.22	31.0	a	-	-	No	Does Not Exceed Background	0.37 to 37	891 to 89100	23.00
Arsenic	NA	NA	No	7.4	6.7	1.11	13.6	6.7	2.05	16/16 100%	No	Comparable to, & enveloped within, regional and national values. No apparent elevations.	Yes	Yes	Arsenic	13.62	0.37 to 37	a	500	1	No	Does Not Exceed Benchmark	19,211.00	46,734,872.00	8,500.00
Barium	NA	NA	No	169.1	494.0	0.34	245.7	494.0	0.50	16/16 100%	No	Comparable to, & enveloped within, regional and national values. No apparent elevations.	No	No	Barium	245.70	5,500.0	a	879	1	No	Does Not Exceed Background	0.15	363.00	0.15
Beryllium	NA	NA	No	0.5	1.5	0.32	0.7	1.5	0.42	16/16 100%	No	Comparable to, & enveloped within, regional and national values. No apparent elevations.	No	No	Beryllium	0.69	0.15 to 15	a	-	-	No	Does Not Exceed Background	274.00	669,498.00	39.00
Cadmium	NA	NA	No	0.2	ND	NA	0.6	ND	NA	6/16 38%	No	Comparable to U.S. Surface Soils. Well Below the U.S. Native Soils Maximum	No	No	Cadmium	0.59	39.0	a	1.0	1	No	Does Not Exceed Background	1,372.00	3,342,491.00	390/6100
Chromium	1	2E-05	Yes	7.0	52.0	0.13	9.6	52.0	0.19	16/16 100%	No	Comparable to, & enveloped within, regional and national values. No apparent elevations.	No	No	Chromium	9.62	390.0	a	-	-	No	Does Not Exceed Background	(a)	(a)	4,700.00
Cobalt	0.06	1E-05	Yes	5.9	5.6	1.05	8.5	5.6	1.52	16/16 100%	No	Comparable to, & enveloped within, regional and national values. No apparent elevations.	Yes	No	Cobalt	8.49	4,700.0	a	-	-	Yes I/E	Exceeds Background. No Ecological Benchmark	10,154.00	24,734,432.00	2,900.00
Copper	0.037	3E-04	Yes	58.0	21.8	2.66	166.6	21.8	7.64	16/16 100%	No	Generally elevated relative regional and national values. Apparent elevation.	Yes	Yes	Copper	166.61	2,900.0	a	364	1	No	Does Not Exceed Benchmark			
Iron	0.26	2E-02	Yes	11,331.3	17,176.0	0.66	14,898.2	17176.0	0.87	16/16 100%	No	Comparable to, & enveloped within, regional and national values. No apparent elevations.	No	No	Iron	14,898.16	-	-	12987	1	No	Exceeds Background. Not Normally Toxic	1,900.00	3,253,740.00	
Lead	NA	NA	No	13.0	29.0	0.45	19.8	29.0	0.68	16/16 100%	No	Comparable to, & enveloped within, regional and national values. No apparent elevations.	No	No	Lead	19.84	180.0	b	39	1	No	Exceeds Background. Not Normally Toxic	36,421.00	93,589,744.00	390.00
Manganese	0.005	8E-04	Yes	383.1	223.0	1.72	472.6	223.0	2.12	16/16 100%	No	Comparable to, & enveloped within, regional and national values. No apparent elevations.	Yes	No	Manganese	472.57	390.0	a	18162	1	Yes H	Exceeds Background. Historical. Exceeds Benchmark	82.00	200,549.00	23.00
Mercury	NA	NA	No	0.02	0.03	ERR	0.03	0.03	1.00	7/16 44%	No	Comparable to, & enveloped within, regional and national values. No apparent elevations.	No	No	Mercury	0.03	23.0	a	0.6	1	No	Does Not Exceed Background			390.00
Molybdenum	0.005	5E-05	Yes	1.6	ND	NA	2.8	ND	NA	16/16 100%	No	Comparable to, U.S. Surface Soils, Western U.S. & Native Soils. Below Mancos Shale Mean	No	Yes	Molybdenum	2.81	390.0	a	-	-	No	Does Not Exceed Background	5,489.00	13,369,963.00	1,600.00
Nickel	NA	NA	No	10.8	13.7	0.79	13.1	13.7	0.96	16/16 100%	No	Comparable to, & enveloped within, regional and national values. No apparent elevations.	No	Yes	Nickel	13.11	1,600.0	a	-	-	No	Does Not Exceed Background. No Eco Benchmark	1,372.00	3,342,491.00	390.00
Selenium	0.005	3E-05	Yes	0.6	0.6	0.96	1.6	0.6	2.65	5/16 31%	No	Comparable to, & enveloped within, regional and national values. No apparent elevations.	Yes	No	Selenium	1.63	390.0	a	7.4	1	No	Exceeds Background. Does Not Exceed Benchmark	1,372.00	3,342,491.00	390.00
Silver	NA	NA	No	0.1	ND	NA	0.3	ND	NA	2/16 13%	No		No	No	Silver	0.30	390.0	a	8442	1	No	Does Not Exceed Background	22.00	53,480.00	
Thallium	NA	NA	No	0.2	ND	NA	0.5	ND	NA	4/16 25%	No	Comparable to U.S. Surface Soils. Well below Western U.S.	No	No	Thallium	0.45	5,348.0	a	-	-	No	Does Not Exceed Background			47,000.00
Tin	NA	NA	No	2.0	1.2	1.63	2.8	1.2	2.34	16/16 100%	No	Mean slightly higher; range within regional and national values. No apparent elevations	Yes	No	Tin	2.81	47,000.0	a	-	-	Yes I E	Exceeds Background. Historical. No Eco Benchmark			230.00
Uranium	NA	NA	No	17.8	2.8	6.35	41.3	2.8	14.74	4/4 100%	No	Generally elevated relative regional and national values. Apparent elevation.	Yes	Yes	Uranium	41.26	230.0	a	364	-	Yes I H E	Exceeds Background. Historical	1,921.00	4,679,487.00	660.00
Vanadium	NA	NA	No	105.7	77.6	1.36	341.2	77.6	4.40	16/16 100%	No	Generally elevated relative regional and national values. Apparent elevation.	Yes	Yes	Vanadium	341.19	550.0	a	-	-	Yes I H E	Exceeds Background. Historical	82,331.00	200,549,451.00	23,000.00
Zinc	0.3	1E-04	Yes	50.5	53.0	0.95	68.5	53.0	1.29	16/16 100%	No	Comparable to, & enveloped within, regional and national values. No apparent elevations.	Yes	Yes	Zinc	68.49	23,000.0	a	-	-	Yes I E	Exceeds Background. Historical. No Eco Benchmark			
Pb-210	NA	NA		Site and Background Data Not Available			ND	NA	NA				No Monitoring Data	Unknown	Yes	Pb-210	ND	1.2 to 120	b	-	-	Yes H/E	No Data to Base Determination	57 pCi/g 64 pCi/g	767 pCi/g 1585 pCi/g	
Ra-226	NA	NA		17.91	ND	NA	61.36	ND	NA	28/28 100%	No	Creek Visibly Elevated.(mean, range) Above Western U.S. (Ra from Schacklette @ all Ra-226 #)	Yes	Yes	Ra-226	61.36	0.01 to 1	b	-	-	Yes I H/E	Exceeds Background. Historical. No Eco Benchmark	57.00		
Th-230	NA	NA		Site and Background Data Not Available			ND	NA	NA				No Monitoring Data	Unknown	Yes	Th-230	ND	57.7 to 5770	b	-	-	Yes H/E	No Data to Base Determination			

Boundaries
Up Gradient: Wells Hydrologically Up Gradient of the MMTS
Canyon: Fall 1994 Terrace Soil Confirmation Samples Collected in and Near Montezuma Canyon.
Seven Counties: 1981 Surficial Materials from Grand, San Juan, and Wayne Counties in Utah;
and Mesa, Montezuma, Montrose, and San Miguel Counties in Colorado (Boergen and Shacklett, 1981. USGS Open File Report 81-197)

Benchmarks
Human
a) USEPA Region III RBC, 1E-6 to 1E-4 Residential Risk
b) USEPA Region III RBC, 0.1 HQ Residential Risk
c).Computed 1E-6 to 1E-4 Risk for Residential
d) Computed HQQ = 0.1 Residential Risk

Ecological
1) Computed Most Sensitive Ecological Receptor

* Low Detection Frequency in the Canyon and 7 Counties Data Sets Introduces Statistical Bias. Weight of Evidence Indicates Natural Levels of Hg in Both Sets
# Note: Historical Evidence, Yes = Characteristic of Ore From the Salt Wash Member of the Morrison Formation (USDOE,1984) and/or Likely Related Radionuclide from the Uranium Series.
@ Note: Step 1 Findings Identify All Remaining Candidate Compounds for Toxicity/Concentration and Regulatory Screen
NA Not Applicable
YI: Benchmarks Not Available. Include as COPC to Err on Side of Safety

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Table C-6. Soils Less Than Six Inches (6"), Stage I Preliminary Contaminants of Potential Concern (COPCs)

Step 1. Assessment of Contamination | Step 2. Assessment of Health and Regulatory Benchmark Screens

	Essential Nutrient			Background Comparisons					Detection Frequency				Historical Evidence	Step 1 Findings BOLD= Candidate @ Note	Montezuma Canyon 95% UCL mg/kg or pCi/g		Finding				Residential (Soils) mg/kg	Recreational (Sediments) mg/kg	Region III RBC's mg/kg
	Region VIII Guideline (mg/kg-day)	Computed 95% UCL Intake (mg/kg-day)	Delete as Nutrient	Montezuma Canyon Mean	7 Counties Mean	Montezuma Canyon/7 C Ratio	Montezuma Canyon 95% UCL	7 Counties Mean	Montezuma Canyon 95% UCL /7 Counties Mean Ratio	Det/Samp. %	Greater or Equal to 5%	Observation from Visual Presentation (see attached data summaries and bar graphs)	Exceeds B.G.	@ Note		Most Stringent Benchmarks Human Health Ref. Ecological Ref. COPC Summary of COPC Finding								
U-234	NA	Site and Background Data Not Available				No Site or Background Data							Unknown	Yes	U-234	ND	47.9 to 4790	•	•	Yes H/E	No Data to Base Determination			
U-235	NA	Site and Background Data Not Available				No Site or Background Data							Unknown	Yes	U-235	ND	0.17 to 17	•	•	Yes H/E	No Data to Base Determination			
U-238	NA	Site and Background Data Not Available				No Site or Background Data							Unknown	Yes	U-238	ND	0.0 to 90	•	•	Yes H/E	No Data to Base Determination			

Note: Historical Evidence, Yes = Characteristic of Ore From the Salt Wash Member of the Morrison Formation (USDOE,1984) and/or Likely Related Radionuclide from the Uranium Series.

Boundaries
Canyon: Fall 1994 Terrace Soil Confirmation Samples Collected In and Near Montezuma Canyon.
Seven Counties: 1981 Surficial Materials from Grand, San Juan, and Wayne Counties in Utah; and Mesa, Montezuma, Montrose, and San Miguel Counties in Colorado (Boergen and Shacklett, 1981. USGS Open File Report 81-197)

Benchmarks

Human
a) USEPA Region III RBC, 1E-6 to 1E-4 Residential Risk
b) USEPA Region III RBC, 0.1 HQ Residential Risk
c) Computed 1E-6 to 1E-4 Risk for Residential
d) Computed HQ = 0.1 Residential Risk

Ecological
1) Computed Most Sensitive Ecological Receptor

* Low Detection Frequency in the Canyon and 7 Counties Data Sets Introduces Statistical Bias. Weight of Evidence Indicates Natural Levels of Hg in Both Sets
# Note: Historical Evidence, Yes = Characteristic of Ore From the Salt Wash Member of the Morrison Formation (USDOE,1984) and/or Likely Related Radionuclide from the Uranium Series.
@ Note: Step 1 Findings Identify All Remaining Candidate Compounds for Toxicity/Concentration and Regulatory Screen
NA Not Applicable
YI: Benchmarks Not Available. Include as COPC to Err on Side of Safety

ATTACHMENT:

Figure X-y Illustration of The Conceptual Model Consideration in PCOC Analysis

	Uranium	Vanadium	Manganese	Barium	Boron	Aluminum	Calcium
Average Up Gradient	4.9	3.4	96.3	96.9	60.9	990.9	263911.1
Average Onsite	2072.3	13403.2	4119.7	83.1	169.9	1332.4	297420
Average Down Gradient	816.7	348.2	796.3	97.1	131.6	3039.2	262068.3

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Step 1. Assessment of Contamination

	Region VIII Guideline (mg/kg-day)	Computed 95% UCL Intake (mg/kg-day)	Delete as Nutrient	Montezuma Canyon Mean	7 Counties Mean	Montezuma Canyon/7 County Ratio	Montezuma Canyon 95% UCL	7 Counties Mean	Montezuma Canyon 95% UCL / 7 Counties Mean Ratio	Det/Samp	%	Greater or Equal to 5%	Observation from Visual Presentation	Exceeds B.G.	# Note	Step 1 Findings BOLD=Candidate @ Note	Montezuma Canyon 95% UCL mg/kg or pCi/g	Human Health	Ref.	Ecological	Ref.	Finding COPC	Summary of COPC Findings	Residential (Soils) mg/kg	Recreational (Sediments) mg/kg	Region III RBC's mg/kg
Aluminum	NA	NA	No	7,623.0	53,529.0	0.1	9,611.1	53529.0	0.2	28/28	100%	No	Comparable to, & enveloped within, regional and natio	No	No	Aluminum	9,611.08	7,800.0	a	-	-	No	Does Not Exceed Background	(a)		78,000.00
Antimony	NA	NA	No	2.7	0.8	NA	6.2	0.8	NA	0/28	0%	Yes	Not detected on Creek samples.	No	No	Antimony	6.16	3.1	a	-	-	No	Does Not Exceed Background	110.00	267,400.00	31.00
Arsenic	NA	NA	No	10.2	6.7	1.5	23.2	6.7	3.5	28/28	100%	No	Comparable to, & enveloped within, regional and natio	Yes	Yes	Arsenic	23.17	23 to 2300	a	500	1	Yes H	Exceeds Background, Historical, Exceeds Benchmark	0.37 to 37	891 to 89100	23.00
Barium	NA	NA	No	216.8	494.0	0.4	398.5	494.0	0.8	28/28	100%	No	Comparable to, & enveloped within, regional and natio	No	No	Barium	398.52	550.0	a	35714	1	No	Does Not Exceed Background	19,211.00	46,794,872.00	5,500.00
Beryllium	NA	NA	No	0.5	1.6	0.3	0.6	1.6	0.4	28/28	100%	No	Comparable to, & enveloped within, regional and natio	No	No	Beryllium	0.61	0.15 to 15	a	-	-	No	Does Not Exceed Background	0.15	363.00	0.15
Cadmium	NA	NA	No	0.3	ND	NA	0.9	ND	NA	15/28	54%	No	Comparable to U.S. Surface Soils, Well Below the U.	No	No	Cadmium	0.94	3.9	a	1.8	1	No	Does Not Exceed Background	274.00	668,498.00	39.00
Chromium	1	1E-05	Yes	6.4	52.0	0.1	8.9	52.0	0.2	28/28	100%	No	Comparable to, & enveloped within, regional and natio	No	No	Chromium	8.93	39.0	a	-	-	No	Does Not Exceed Background	1,372.00	3,342,491.00	390/5100
Cobalt	0.06	2E-05	Yes	6.5	5.6	1.2	11.9	5.6	2.1	28/28	100%	No	Comparable to, & enveloped within, regional and natio	Yes	No	Cobalt	11.91	470.0	a	-	-	Yes I E	Exceeds Background, No Ecological Benchmark	(a)	(a)	4,700.00
Copper	0.037	7E-04	Yes	126.3	21.8	5.8	457.3	21.8	21.0	28/28	100%	No	Generally elevated relative regional and national value	Yes	Yes	Copper	457.25	290.0	a	364	1	Yes H/E	Exceeds Background, Historical, Exceeds Benchmark	10,154.00	24,734,432.00	2,900.00
Iron	0.26	2E-02	Yes	11,657.6	17,176.0	0.7	13,702.2	17176.0	0.8	28/28	100%	No	Comparable to, & enveloped within, regional and natio	No	No	Iron	13,702.17	-	-	12987	1	No	Exceeds Background, Not Normally Toxic			
Lead	NA	NA	No	16.1	29.0	0.6	25.7	29.0	0.9	28/28	100%	No	Comparable to, & enveloped within, regional and natio	No	No	Lead	25.66	180.0	b	39	1	No	Exceeds Background, Not Normally Toxic	1,800.00	3,253,740.00	
Manganese	0.005	9E-04	Yes	351.5	223.0	1.6	524.2	223.0	2.4	28/28	100%	No	Comparable to, & enveloped within, regional and natio	Yes	No	Manganese	524.23	39.0	a	18182	1	Yes H	Exceeds Background, Historical, Exceeds Benchmark	38,421.00	93,589,744.00	390.00
Mercury	NA	NA	No	0.02	0.0	0.0	0.03	0.03	0.0	15/28	54%	No	Comparable to, & enveloped within, regional and natio	No	No	Mercury	0.03	2.3	a	0.6	1	No	Does Not Exceed Background	82.00	200,549.00	23.00
Molybdenum	0.005	1E-05	Yes	2.7	ND	NA	7.0	ND	NA	28/28	100%	No	Comparable to: U.S. Surface Soils, Western U.S., and	No	Yes	Molybdenu	7.02	39.0	a	-	-	No	Does Not Exceed Background			390.00
Nickel	NA	NA	No	10.9	13.7	0.8	13.1	13.7	1.0	28/28	100%	No	Comparable to, & enveloped within, regional and natio	No	Yes	Nickel	13.09	160.0	a	-	-	No	Does Not Exceed Background, No Eco Benchmark	5,489.00	13,369,963.00	1,600.00
Selenium	0.005	1E-05	Yes	1.6	0.6	2.6	7.5	0.6	12.2	13/28	46%	No	Comparable to, & enveloped within, regional and natio	Yes	No	Selenium	7.53	39.0	a	7.4	1	Yes E	Exceeds Background, Exceeds Benchmark	1,372.00	3,342,491.00	390.00
Silver	NA	NA	No	0.2	ND	NA	0.4	ND	NA	10/28	36%	No		No	No	Silver	0.40	39.0	a	8442	1	No	Does Not Exceed Background	1,372.00	3,342,491.00	390.00
Thallium	NA	NA	No	0.2	ND	NA	0.4	ND	NA	11/28	39%	No	Comparable to U.S. Surface Soils, Well below Wester	No	No	Thallium	0.41	5,348.0	b	-	-	No	Does Not Exceed Background	22.00	53,480.00	
Tin	NA	NA	~ No	2.1	1.2	1.8	2.8	1.2	2.3	28/28	100%	No	Mean slightly higher; range within regional and national	Yes	No	Tin	2.80	4,700.0	a	-	-	Yes I E	Exceeds Background, Historical, No Eco Benchmark			47,000.00
Uranium	NA	NA	No	34.2	2.8	12.2	79.1	2.8	28.3	8/8	100%	No	Generally elevated relative regional and national value	Yes	Yes	Uranium	79.12	23.0	a	-	-	Yes IH /E	Exceeds Background, Historical, No Eco Benchmark			230.00
Vanadium	NA	NA	No	145.5	77.6	1.9	370.1	77.6	4.8	28/28	100%	No	Generally elevated relative regional and national value	Yes	Yes	Vanadium	370.11	55.0	a	-	-	Yes IH /E	Exceeds Background, Historical, No Eco Benchmark	1,821.00	4,679,487.00	550.00
Zinc	0.3	1E-04	Yes	51.7	53.0	1.0	70.1	53.0	1.3	28/28	100%	No	Comparable to, & enveloped within, regional and natio	Yes	Yes	Zinc	70.09	2,300.0	a	-	-	Yes I E	Exceeds Background, Historical, No Eco Benchmark	82,331.00	....	23,000.00
Pb-210	NA	NA	Site and Background Data Not Available				NA		NA				No Monitoring Data	Unknown	Yes	Pb-210	0.00	1.2 to 120	b	-	-	Yes H/E	No Data to Base Determination	57 pCi/g	767 pCi/g	
Ra-226	NA	NA		22.34	ND	NA	61.93	ND	NA	28/28	100%	No	Creek Visibly Elevated (mean, range) Above Western	Yes	Yes	Ra-226	61.93	0.01 to 1	b	-	-	Yes IH /E	Exceeds Background, Historical, Exceeds Benchmark	64 pCi/g	1585 pCi/g	
Th-230	NA	NA	Site and Background Data Not Available				NA		NA				No Monitoring Data	Unknown	Yes	Th-230	0.00	57.7 to 5770	b	-	-	Yes H/E	No Data to Base Determination	57.00		

Boundaries
Up Gradient: Wells Hydrologically Up Gradient of the MMTS
Canyon: Fall 1994 Terrace Soil Confirmation Samples Collected In and Near Montezuma Canyon.
Seven Counties: 1981 Surficial Materials from: Grand, San Juan, and Wayne Counties in Utah;
and Mesa, Montezuma, Montrose, and San Miguel Counties in Colorado (Boemgen and Schacklett, 1981. USGS Open File Report 81-197)

Benchmarks
Human:
a) USEPA Region III RBC, 1E-6 to 1E-4 Residential Risk
b) USEPA Region III RBC, 0.1 HQ Residential Risk
c) Computed 1E-6 to 1E-4 Risk for Residential
d) Computed HOQ = 0.1 Residential Risk

Ecological
1) Computed Most Sensitive Ecological Receptor

*: Low Detection Frequency in the Canyon and 7 Counties Data Sets Introduces Statistical Bias. Weight of Evidence Indicates Natural Levels of Hg In Both Sets
Note: Historical Evidence, Yes = Characteristic of Ore From the Salt Wash Member of the Morrison Formation (USDOE,1984) and/or Likely Related Radionuclides from the Uranium Series.
@ Note: Step 1 Findings Identify all Remaining Candidate Compounds for Toxicity/Concentration and Regulatory Screen
NA: Not Applicable
YI : Benchmark Not Available. Include as COPC to Err on Side of Safety

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Step 1, Assessment of Contamination

	Essential Nutrient			Background Comparisons					Detection Frequency				Historical Evidence	Step 1 Findings		Most Stringent Benchmarks			Finding		Residential	Recreational	Region III
	Region VIII Guideline (mg/kg-day)	Computed 95% UCL Intake (mg/kg-day)	Delete as Nutrient	Montezuma Canyon Mean	7 Counties Mean	Montezuma Canyon/7 County Ratio	Montezuma Canyon 95% UCL Mean	7 Counties / 7 Counties Mean Ratio	Montezuma Canyon 95% UCL Mean	7 Counties/7 County Ratio	Det/Samp. %	Greater or Equal to 5%	Observation from Visual Presentation (see attached data summaries and bar graphs)	Exceeds B.G.	@ Note	BOLD= Candidate @ Note	Montezuma Canyon 95% UCL mg/kg or pCi/g	Human Health Ref.	Ecological Ref.	COPC	Summary of COPC Findings	(Soils) mg/kg	(Sediments) mg/kg	RBC's mg/kg
U-234	NA	Site and Background Data Not Available				No Site or Background Data								Unknown	Yes	U-234	No Data	47.9 to 4790 c	-	-	Yes	No Data to Base Determination			
U-235	NA	Site and Background Data Not Available				No Site or Background Data								Unknown	Yes	U-235	No Data	0.17 to 17 c	-	-	Yes	No Data to Base Determination			
U-238	NA	Site and Background Data Not Available				No Site or Background Data								Unknown	Yes	U-238	No Data	0.9 to 90 c	-	-	Yes	No Data to Base Determination			

Boundaries
Canyon: Fall 1994 Terrace Soil Confirmation Samples Collected In and Near Montezuma Canyon.
Seven Counties: 1981 Surficial Materials from: Grand, San Juan, and Wayne Counties in Utah;
and Mesa, Montezuma, Montrose, and San Miguel Counties in Colorado (Boerngen and Shacklett, 1981. USGS Open File Report 81-197)

Benchmarks

Human
a) USEPA Region III RBC, 1E-6 to 1E-4 Residential Risk
b) USEPA Region III RBC, 0.1 HQ Residential Risk
c) Computed 1E-6 to 1E-4 Risk for Residential
d) Computed HQ = 0.1 Residential Risk

Ecological
1) Computed Most Sensitive Ecological Receptor

*: Low Detection Frequency in the Canyon and 7 Counties Data Sets Introduces Statistical Bias. Weight of Evidence Indicates Natural Levels of Hg In Both Sets
Note: Historical Evidence, Yes = Characteristic of Ore From the Salt Wash Member of the Morrison Formation (USDOE,1984) and/or Likely Related Radionuclides from the Uranium Series.
@ Note: Step 1 Findings Identify all Remaining Candidate Compounds for Toxicity/Concentration and Regulatory Screen
NA: Not Applicable
YI: Benchmark Not Available. Include as COPC to Err on Side of Safety

ATTACHMENT:

Figure X-y   Illustration of The Conceptual Model Consideration in PCOC Analysis

	Uranium	Vanadium	Manganese	Barium	Boron	Aluminum	Calcium
Average Up Gradient	4.9	3.4	98.3	66.9	59.9	990.8	263911.1
Average Onsite	2072.3	13403.2	4118.7	53.1	159.9	1332.4	287420
Average Down Gradient	816.7	348.2	765.3	97.1	131.5	3038.2	262058.3

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Table C-10. Montezuma Creek Soils Less Than Six Inches
Human Health and Ecological COPCs

Compound	Human Health	Ecological
Cobalt		$X^{(1)}$
Manganese	X	
Tin		$X^{(1)}$
Elemental U	X	$X^{(1)}$
Vanadium	X	$X^{(1)}$
Zinc		$X^{(1)}$
Pb-210	$X^{(2)}$	$X^{(2)}$
Ra-226	X	$X^{(1)}$
U-234	$X^{(2)}$	$X^{(2)}$
U-235	$X^{(2)}$	$X^{(2)}$
U-238	$X^{(2)}$	$X^{(2)}$

(1) Benchmarks not identified currently. Retained as COPCs to err on the side of safety.
(2) No data to base a determination. Included as COPC considering historical evidence and erring on the side of safety.

C2.3.3.2 Montezuma Creek Soils Greater Than Six Inches

Table C-9 illustrates the analysis for the Montezuma Creek soils collected from a depth of greater than six inches. The findings are presented in Table C-11.

Table C-11. Montezuma Creek Soils Greater Than 6 Inches
Human Health and Ecological COPCs

Compound	Human Health	Ecological
Arsenic	X	
Cobalt		$X^{(1)}$
Copper	X	X
Manganese	X	
Selenium		X
Tin		$X^{(1)}$
Elemental U	X	$X^{(1)}$
Vanadium	X	$X^{(1)}$
Zinc		$X^{(1)}$
Pb-210	$X^{(2)}$	$X^{(2)}$

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**Table C-11. Montezuma Creek Soils Greater Than 6 Inches
Human Health and Ecological COPCs (Continued)**

Compound	Human Health	Ecological
Arsenic	X	
Ra-226	X	X[1]
U-234	X[2]	X[2]
U-235	X[2]	X[2]
U-238	X[2]	X[2]

[1] Benchmarks not identified currently. Retained as COPCs to err on the side of safety.
[2] No data to base a determination. Included as COPC considering historical evidence and erring on the side of safety.

Inspection of Table C-11 reveals that 12 COPCs have been identified in the deeper than six inch portion of the Montezuma Creek soils. Similar to Table C-9 the scarcity of benchmarks and sampling data result in many compounds being retained simply through default.

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Annex C-1

NOVEMBER SUM STATS

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Group Statistics for Upper Flow System Samples Collected
November 1992 through May 1994

Ag   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	-	1 - 7	0 / 35	2.11	2.11	.1	5.01	2.38
On-Site	4.3[a] - 6.7[a]	1 - 7	2 / 44	2.19	2.11	.6	27.64	3.57
Up-Gradient	-	1 - 7	0 / 17	2.1	2.1	.09	4.38	2.5

Al   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	10.4[a] - 108000	9 - 29	22 / 35	3039.22	99.97	7347.86	241.76	21923.23
On-Site	18.7[a] - 9670	9 - 29	40 / 43	1332.36	191.96	3022.32	226.83	8162.82
Up-Gradient	17.2[a] - 3920	-	17 / 17	990.79	771.05	644.53	65.05	3762.28

Alky in ppm

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	274 - 430	-	35 / 35	383.17	382.78	18.78	4.9	431.44
On-Site	260 - 1448	-	41 / 41	476.14	456.36	151.38	31.79	818.27
Up-Gradient	90 - 701	-	17 / 17	274.16	272.55	36.77	13.41	432.27

.Alpha in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	200 - 2300	16 - 16	34 / 35	586.78	496.37	417.22	71.1	1659.03
On-Site	39 - 9780	26 - 162	34 / 43	1524.4	578.67	1400.52	91.87	4689.58
Up-Gradient	-	12.1 - 52	0 / 17	15.2	13.91	7.47	49.16	47.35

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[a]Estimated value.

Group Statistics for Upper Flow System Samples Collected
November 1992 through May 1994

As in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	3.3[a] - 131	2 - 4	21 / 35	14.06	7.1	14.59	103.72	51.56
On-Site	2.5[a] - 469	2 - 4	33 / 44	76.13	20.98	125.86	165.31	360.59
Up-Gradient	3.0[a] - 5.0[a]	2 - 4	4 / 17	1.99	1.99	.17	8.56	2.73

B in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	66.2[a] - 544	-	35 / 35	131.5	128.69	31.62	24.04	212.77
On-Site	44.4[a] - 439	-	43 / 43	159.92	142.02	102.27	63.95	391.05
Up-Gradient	33.9[a] - 107	-	17 / 17	59.94	59.01	12.62	21.06	114.23

Ba in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	8.9[a] - 2250	-	35 / 35	97.09	49.5	150.93	155.46	484.99
On-Site	8.2[a] - 286	-	44 / 44	53.12	39.13	49.1	92.44	164.09
Up-Gradient	17.7[a] - 147[a]	-	17 / 17	66.94	58.91	35.1	52.44	217.9

Be in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	6.2 - 6.2	1 - 1	1 / 23	.73	.62	.57	78.69	2.22
On-Site	-	1 - 1	0 / 29	.5	.5	0	0	.5
Up-Gradient	1.1[a] - 1.1[a]	1 - 1	1 / 11	.55	.54	.08	15.74	.92

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[a]Estimated value.

Group Statistics for Upper Flow System Samples Collected
November 1992 through May 1994

Beta in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	40 - 1040	19.2 - 19.2	34 / 35	220.43	189.37	140.41	63.69	581.3
On-Site	159 - 3300	19.8 - 193	30 / 43	494.25	234.01	406.39	82.22	1412.7
Up-Gradient	-	7 - 52	0 / 17	12.19	11.22	5.72	46.89	36.79

CDT in umhos/cm

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	1073 - 3420	-	34 / 34	2302.38	2294.25	209	9.07	2839.53
On-Site	495 - 7960	-	44 / 44	3236.56	2944.78	1645.29	50.83	6954.93
Up-Gradient	514 - 2570	-	18 / 18	1349.83	1219.24	702.67	52.05	4371.33

CN in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	4.9[a] - 10.3	4 - 10	4 / 23	4.43	4.31	1.23	27.81	7.59
On-Site	4.2[a] - 4.2[a]	4 - 10	1 / 28	3.57	3.57	.2	5.8	4.08
Up-Gradient	-	4 - 10	0 / 11	3.33	3.32	.28	8.66	4.57

Ca in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	53700 - 408000	-	35 / 35	262058.33	260226.02	35009.46	13.35	352032.66
On-Site	19500 - 606000	-	44 / 44	287419.99	247916.74	142140.67	49.45	608657.91
Up-Gradient	92000 - 517000	-	17 / 17	263911.1	238478.22	141006.26	53.42	870238.03

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[a]Estimated value.

Group Statistics for Upper Flow System Samples Collected
November 1992 through May 1994

Cd in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	2.0[a] - 2.0[a]	1 - 1	1 / 35	.54	.53	.1	18.84	.8
On-Site	1.3[a] - 3.2[a]	1 - 3	2 / 44	.63	.59	.3	47.36	1.31
Up-Gradient	-	1 - 1	0 / 17	.5	.5	0	0	.5

Cl in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	18900 - 207000	-	35 / 35	97770.55	95735.4	22082.5	22.58	154522.59
On-Site	6750 - 687000	-	44 / 44	124798.74	76183.63	185015.39	148.25	542933.54
Up-Gradient	2820 - 17100	-	17 / 17	9918.77	9672.36	2740.65	27.63	21703.59

Co in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	61.2 - 61.2	6 - 10	1 / 12	8.68	5.65	11.47	132.11	38.16
On-Site	8.8[a] - 24.9[a]	6 - 10	4 / 14	7.87	6.18	7.31	92.94	25.79
Up-Gradient	-	6 - 10	0 / 5	3.66	3.63	.57	15.74	6.14

Cr in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	3.4[a] - 79.7	3 - 6	4 / 35	4.35	3.08	5.11	117.58	17.49
On-Site	3.6[a] - 14.0	3 - 6	12 / 44	3.61	3.24	1.84	51.04	7.79
Up-Gradient	3.4[a] - 10.6	3 - 6	4 / 17	2.96	2.83	1.12	37.88	7.79

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[a]Estimated value.

Group Statistics for Upper Flow System Samples Collected
November 1992 through May 1994

Cu in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	3.4[a] - 197	2 - 5	9 / 35	8.89	4.39	13.29	149.42	43.06
On-Site	2.3[a] - 465	2 - 5	13 / 44	30.42	5.1	64.34	211.48	175.83
Up-Gradient	4.1[a] - 6.1[a]	2 - 5	2 / 17	2.09	2.06	.43	20.54	3.94

DO in mg/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	0.26 - 4.68	-	34 / 34	1.35	1.24	.58	43.1	2.84
On-Site	0.49 - 6.71	-	33 / 33	2.34	2.21	.76	32.64	4.15
Up-Gradient	2.45 - 7.58	-	10 / 10	4.99	4.7	2	40.19	13.61

F in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	100[a] - 457	-	35 / 35	259.71	246.13	87.62	33.74	484.92
On-Site	60.3[a] - 3750	-	44 / 44	769.44	418.86	1039.56	135.1	3118.86
Up-Gradient	62.3[a] - 199[a]	-	17 / 17	127.68	126.75	18.56	14.54	207.51

Fe in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	5.9[a] - 165000	10 - 19	31 / 35	4811.89	223.77	11168.75	232.1	33515.6
On-Site	7.3[a] - 14600	19 - 19	43 / 44	1946.6	433.35	2626.04	134.9	7881.46
Up-Gradient	54.7[a] - 6180	-	17 / 17	1402.01	1100.2	917.33	65.42	5346.55

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[a]Estimated value.

Group Statistics for Upper Flow System Samples Collected
November 1992 through May 1994

H2O in feet

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	3.14 - 19.05	-	33 / 33	9.88	9.29	4.23	42.88	20.77
On-Site	3.55 - 53.45	-	43 / 43	22.05	16.03	16.04	72.74	58.31
Up-Gradient	6.84 - 22.04	-	18 / 18	14.96	14.26	5.85	39.11	40.13

Hg in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	-	.1 - .1	0 / 23	.05	.04	0	0	.05
On-Site	-	.1 - .2	0 / 29	.05	.05	.01	31.42	.09
Up-Gradient	-	.1 - .1	0 / 11	.05	.04	0	0	.05

K in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	770[a] - 29400	-	35 / 35	13385.55	10040.23	8419.38	62.89	35023.37
On-Site	2640[a] - 116000	-	44 / 44	31971.16	18660.95	29740.5	93.02	99184.7
Up-Gradient	1200[a] - 3950	-	17 / 17	2238.33	2224.7	307.17	13.72	3559.19

Mg in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	10800 - 90800	-	35 / 35	58829.99	58374.06	7921.86	13.46	79189.18
On-Site	5360 - 160000	-	44 / 44	68719.66	54198.67	42470.55	61.8	164703.12
Up-Gradient	10800 - 76600	-	17 / 17	38227.77	32505.59	24115.11	63.08	141922.78

[a]Estimated value.

Group Statistics for Upper Flow System Samples Collected
November 1992 through May 1993

Mn in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	2.3[a] - 11400	-	35 / 35	765.29	457.94	732.77	95.75	2648.51
On-Site	12.5[a] - 12900	-	43 / 43	4118.68	1184.33	4589.93	111.44	14491.92
Up-Gradient	1.2[a] - 520	-	17 / 17	98.22	83.38	57.41	58.45	345.1

Mo in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	2.1[a] - 240	22 - 27	31 / 35	87.21	56.2	71.49	81.97	270.94
On-Site	2.1[a] - 2150	22 - 27	40 / 44	472.71	139.33	571.99	121	1765.42
Up-Gradient	1.4[a] - 3.8[a]	1 - 27	9 / 17	5.58	5.56	.63	11.44	8.33

NH4 in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	19 - 4840	-	35 / 35	547.58	137.83	1133.76	207.04	3461.35
On-Site	12.0[a] - 26700	-	43 / 43	6262.34	1436.76	7420.22	118.48	23032.05
Up-Gradient	21.0 - 80	20 - 20	16 / 17	42.76	42.38	6.78	15.86	71.94

NO2 in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	3.3[a] - 338[a]	4 - 20	19 / 23	42.16	26.87	46.77	110.93	162.36
On-Site	6.7[a] - 1470	2 - 8	24 / 30	81.47	28.01	146.86	180.25	441.28
Up-Gradient	3.9[a] - 21.2[a]	2 - 8	7 / 11	7.28	6.38	4.38	60.25	26.15

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[a] Estimated value.

Group Statistics for Upper Flow System Samples Collected
November 1992 through May 1994

NO3 in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	36.9[a] - 53700	10 - 10	22 / 23	14052.92	5812.07	9777.88	69.57	39182.09
On-Site	19.1[a] - 266000	-	29 / 29	38338.24	3063.24	85608.64	223.29	248079.43
Up-Gradient	31.8[a] - 20900	-	11 / 11	3863.81	2542.42	2934.76	75.95	16483.29

NO3+NO2-N in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	17.5[a] - 3700	-	12 / 12	1465.82	721.55	1169.64	79.79	4471.81
On-Site	7.0[a] - 43200	.9035 - .9035	14 / 15	6049.34	472.79	15041.06	248.63	41546.25
Up-Gradient	41.8[a] - 4330	-	6 / 6	1265.63	540.68	1240.06	97.97	6597.89

Na in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	58300 - 348000	-	35 / 35	212311.1	207662.46	49051.8	23.1	338374.23
On-Site	46700 - 1630000	-	44 / 44	474848.33	310653.42	451486.69	95.08	495208.25
Up-Gradient	23100 - 64800	-	17 / 17	38889.99	37564.92	12746.93	32.77	93701.83

Ni in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	10.3[a] - 130	6 - 14	6 / 35	9.45	7.58	8.62	91.2	31.6
On-Site	7.3[a] - 63.1	6 - 14	23 / 44	14	10.58	14.77	105.49	47.4
Up-Gradient	-	6 - 14	0 / 17	4.96	4.96	.05	1.16	5.21

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[a]Estimated value.

Group Statistics for Upper Flow System Samples Collected
November 1992 through May 1994

Pb   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	1.2[a] - 89.1	1 - 1	10 / 35	3.9	1.67	5.9	151.38	19.07
On-Site	1.2[a] - 52.8	1 - 1	17 / 44	4.64	2.02	6.99	150.7	20.46
Up-Gradient	1.1[a] - 11.3	1 - 1	9 / 17	2.43	1.87	1.62	66.92	9.42

Pb210 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	2.7 - 21.0	2 - 2	19 / 29	6.42	4.95	4.19	65.29	17.21
On-Site	2.0 - 79.0	2 - 2	20 / 36	14.07	5.57	23.61	167.78	67.45
Up-Gradient	-	2 - 2	0 / 15	1	1	0	0	1

Po210 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	0.72 - 6.9	.06 - 6.33	2 / 35	.4	.21	.48	120.79	1.64
On-Site	0.12 - 20.27	.08 - .86	13 / 43	2.48	.37	6.28	252.97	16.69
Up-Gradient	-	.08 - 1.01	0 / 17	.16	.16	.03	18.7	.29

Ra226 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	0.1 - 1.1	.02 - 1.33	13 / 35	.13	.1	.11	87.3	.42
On-Site	0.1 - 16.14	.04 - 1.45	32 / 44	2.06	.57	3.54	171.94	10.07
Up-Gradient	0.1 - 0.56	.05 - .55	8 / 17	.18	.17	.07	38	.49

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[a]Estimated value.

Group Statistics for Upper Flow System Samples Collected
November 1992 through May 1994

Ra228 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	-	1 - 7	0 / 35	1.16	1.16	.13	11.84	1.52
On-Site	-	1 - 7	0 / 44	1.51	1.44	.47	31.44	2.58
Up-Gradient	-	1 - 4	0 / 17	.95	.94	.18	19.28	1.74

Rn222 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	196 - 10591	-	35 / 35	1577.68	1176.27	1618.17	102.56	5736.38
On-Site	99 - 59651	-	43 / 43	4302.12	1647.74	7500.2	174.33	21252.59
Up-Gradient	203 - 1265	-	18 / 18	700.44	696.7	89.95	12.84	1087.23

SO4 in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	250000 - 1320000	-	35 / 35	789266.66	786281.23	73545.23	9.31	978277.92
On-Site	316000 - 2380000	-	44 / 44	295116.66	160347.24	589932.58	45.55	628364.31
Up-Gradient	70800 - 1200000	-	17 / 17	545699.99	400559.95	443546.92	81.28	452951.77

Sb in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	1.2[a] - 1.9[a]	1 - 1	5 / 23	.69	.67	.15	22.93	1.09
On-Site	1.0[a] - 227	1 - 1	4 / 29	28.87	1.18	80.05	277.21	217.8
Up-Gradient	1.2[a] - 2.0[a]	1 - 1	5 / 11	1.04	1.02	.2	19.86	1.92

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[a]Estimated value.

Group Statistics for Upper Flow System Samples Collected
November 1992 through May 1994

Se   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	1.2[a] - 57.4	2 - 3.3	29 / 35	15.59	12.37	8.16	52.38	36.58
On-Site	1.8[a] - 302	2 - 3	32 / 44	30.87	8.37	67.97	220.18	184.5
Up-Gradient	1.5[a] - 5.1[a]	2 - 15	8 / 17	2.84	2.61	1.24	43.71	8.19

Sr   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	1120 - 4740	-	23 / 23	2568.33	2495.24	654.74	25.49	4251.02
On-Site	318 - 4710	-	29 / 29	2667.87	2134.6	1412.13	52.93	6000.5
Up-Gradient	607 - 3650	-	11 / 11	1973.77	1680.6	1380.25	69.92	7908.88

TDS   in mg/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	792 - 2466	-	35 / 35	1748.2	1742.89	149.57	8.55	2132.62
On-Site	886 - 5616	-	44 / 44	2800.07	2525.93	1326.99	47.39	5799.08
Up-Gradient	354[a] - 2264	-	17 / 17	1150.47	989.59	715.24	62.16	4226.01

Temp in deg C

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	6.6 - 14.0	-	35 / 35	9.84	9.83	.47	4.84	11.07
On-Site	5.3 - 17.9	-	43 / 43	10.48	10.46	.62	5.98	11.9
Up-Gradient	4.8 - 12.5	-	18 / 18	8.77	8.75	.72	8.3	11.9

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[a]Estimated value.

Group Statistics for Upper Flow System Samples Collected
November 1992 through May 1994

Th230 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	0.34 - 0.91	.08 - 6.59	4 / 35	.49	.44	.23	46.69	1.08
On-Site	0.34 - 1.06	.07 - 7.79	5 / 43	.51	.27	.46	90.56	1.55
Up-Gradient	0.3 - 0.45	.05 - .3	3 / 17	.11	.11	.01	10.18	.16

Th232 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	0.16 - 0.16	.07 - 4.95	1 / 35	.38	.32	.21	56.57	.94
On-Site	0.46 - 0.88	.05 - 6.82	2 / 43	.33	.17	.36	106.92	1.15
Up-Gradient	0.55 - 0.55	.05 - .3	1 / 17	.09	.09	.03	31.6	.22

Tl in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	1.8[a] - 1.8[a]	1 - 2	1 / 35	.62	.61	.08	14.28	.84
On-Site	1.1[a] - 1.1[a]	1 - 2	3 / 43	.59	.59	.09	15.06	.8
Up-Gradient	-	1 - 2	0 / 17	.58	.58	.01	1.96	.63

U in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	306 - 2870	1 - 1	34 / 35	816.67	694.05	558.08	68.33	2250.94
On-Site	21.7 - 12600	-	44 / 44	2072.34	729.62	1955.05	94.34	6490.77
Up-Gradient	2.8[a] - 7.3	-	17 / 17	4.86	4.8	.84	17.3	8.47

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[a]Estimated value.

Group Statistics for Upper Flow System Samples Collected
November 1992 through May 1994

U234 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	1.07 - 968.26	-	35 / 35	272.23	238.46	164.94	60.58	696.12
On-Site	11.35 - 4096.48	-	43 / 43	686.53	271.67	644.39	93.86	2142.87
Up-Gradient	0.37 - 77.50	.04 - .04	16 / 17	7.31	5.01	7.7	105.4	40.44

U235 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	3.94 - 41.32	8.98 - 16.77	19 / 23	13.27	11.59	8.68	65.43	35.59
On-Site	0.63 - 194.37	.11 - .44	25 / 29	45.29	13.48	43.27	95.55	143.09
Up-Gradient	0.49 - 0.49	.07 - .29	1 / 12	.11	.1	.05	48.1	.33

U238 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	0.52 - 985.64	-	35 / 35	276.53	240.13	172.99	62.55	721.13
On-Site	8.28 - 4288.89	-	43 / 43	700.13	246.36	661.36	94.46	2194.82
Up-Gradient	0.38 - 77.53	.28 - .28	16 / 17	5.86	3.18	7.53	128.53	38.27

U in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	65.7 - 2890	4 - 8	22 / 35	348.2	72.27	384.72	110.48	1336.95
On-Site	9.1[a] - 169000	4 - 8	33 / 44	13403.17	208.01	40413.31	301.52	104737.26
Up-Gradient	4.5[a] - 8.8[a]	4 - 8	3 / 17	3.43	3.39	.6	17.54	6.02

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[a]Estimated value.

Group Statistics for Upper Flow System Samples Collected
November 1992 through May 1994

Zn   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	2.2^a - 500	3 - 7	30 / 35	22.13	11.58	34.05	153.86	109.64
On-Site	3.1^a - 78.7	3 - 7	39 / 44	18.38	13.51	17.29	94.04	57.46
Up-Gradient	2.4^a - 40.5	6 - 7	14 / 17	15.22	13.26	8.65	56.86	52.44

pH   in

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	6.02 - 7.06	-	35 / 35	6.66	6.65	.09	1.38	6.89
On-Site	6.27 - 8.51	-	44 / 44	6.87	6.85	.57	8.4	8.18
Up-Gradient	6.37 - 7.21	-	18 / 18	6.77	6.76	.19	2.87	7.6

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[a]Estimated value.

Group Statistics for Surface Water Samples Collected
November 1992 through May 1994

Ag   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	-	1 - 7	0 / 144	2.16	2.15	0	0	2.16
On-Site	-	1 - 7	0 / 25	2.2	2.2	.04	2.04	2.32
Up-Gradient	-	1 - 7	0 / 22	2.04	2.04	.07	3.81	2.23

Al   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	21.4[a] - 3550	29 - 29	143 / 144	1007.02	751.46	503.52	50	2049.32
On-Site	54.4[a] - 1360	-	25 / 25	443.25	371.46	312.35	70.46	1311.59
Up-Gradient	15.8[a] - 1450	29 - 29	21 / 22	433.02	292.45	480.89	111.05	1611.2

Alky in ppm

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	80 - 418	-	143 / 143	184.89	182.62	31.45	17.01	250.01
On-Site	123 - 548	-	25 / 25	270.82	266.13	57.88	21.37	431.73
Up-Gradient	113 - 1562	-	20 / 20	498.04	357.31	502.52	100.9	1729.23

Alpha in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	27.7 - 350	13.2 - 40	90 / 144	68.73	61.22	38.3	55.72	148.02
On-Site	17.3 - 1900	17.3 - 70	18 / 25	369.8	147.11	523.7	141.61	1825.72
Up-Gradient	60 - 60	9.9 - 61	1 / 22	20.22	17.64	11.1	54.9	47.43

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[a]Estimated value.

Group Statistics for Surface Water Samples Collected
November 1992 through May 1994

As   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	2.9[a] - 15.1	2 - 4	71 / 144	2.83	2.76	.8	28.45	4.5
On-Site	2.5[a] - 1250	2 - 3	18 / 25	139.63	26.14	183.67	131.54	650.25
Up-Gradient	2.4[a] - 11.0	2 - 4	5 / 22	4.38	2.98	4.39	100.29	15.15

B   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	35.2[a] - 130	42 - 42	126 / 144	73.29	73.24	2.61	3.57	78.71
On-Site	38.8[a] - 403	-	25 / 25	133.22	110.59	93.92	70.49	394.33
Up-Gradient	30.1[a] - 140	42 - 42	21 / 22	69.21	61.99	37.6	54.33	161.34

Ba   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	36.1[a] - 103	-	144 / 144	64.43	63.64	9.62	14.94	84.36
On-Site	22.5[a] - 117[a]	-	25 / 25	56.05	54.43	16.13	28.78	100.9
Up-Gradient	24.7[a] - 141[a]	-	22 / 22	83.87	75.92	39.86	47.53	181.54

Be   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	-	1 - 1	0 / 96	.5	.5	0	0	.5
On-Site	-	1 - 1	0 / 17	.5	.5	0	0	.5
Up-Gradient	-	1 - 1	0 / 13	.5	.5	0	0	.5

[a]Estimated value.

Group Statistics for Surface Water Samples Collected
November 1992 through May 1994

Beta in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	12.0 - 130.	19.4 - 33	69 / 144	25.84	23.78	12.69	49.13	52.13
On-Site	25.2 - 1164	10.2 - 47	9 / 25	164.39	55.44	262.7	159.79	894.7
Up-Gradient	26.5 - 26.5	6.7 - 64	1 / 22	16.6	13.72	11.16	67.23	43.96

COT in umhos/cm

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	241 - 1936	-	144 / 144	1183.36	1177.82	121.83	10.29	1435.56
On-Site	733 - 5170	-	25 / 25	1662.51	1615.05	466.15	28.03	2958.44
Up-Gradient	383 - 2080	-	21 / 21	1201.34	1155.02	339.38	28.25	2032.83

CN in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	-	4 - 10	0 / 96	3.5	3.49	0	0	3.5
On-Site	-	4 - 10	0 / 17	3.6	3.57	.41	11.62	4.76
Up-Gradient	-	4 - 10	0 / 13	3.37	3.36	.25	7.4	4.17

COD in mg/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Up-Gradient	15.6 - 23.3	-	2 / 2	19.45	19.06	5.44	27.99	88.65

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[a]Estimated value.

Group Statistics for Surface Water Samples Collected
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Ca   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	45000 - 324000	-	144 / 144	146986.1 -	143132.82	37504.61	25.51	224620.66
On-Site	52700 - 358000	-	25 / 25	202310.33	197937.43	45169.94	22.32	327882.78
Up-Gradient	49600 - 431000	-	22 / 22	165292.38	152264.97	80229.22	48.53	361853.97

Cd   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	-	1 - 1	0 / 144	.5	.5	0	0	.5
On-Site	-	1 - 1	0 / 25	.5	.5	0	0	.5
Up-Gradient	-	1 - 1	0 / 22	.5	.5	0	0	.5

Cl   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	3820 - 70900	-	144 / 144	40567.77	40425.34	3152.69	7.77	47093.84
On-Site	4350 - 452000	-	25 / 25	71579.99	51280.48	58248.93	81.37	233512.04
Up-Gradient	2490 - 316000	▾	22 / 22	69584.61	27733.37	111071.1	159.62	341708.82

Co   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	-	6 - 10	0 / 48	4	4	0	0	4
On-Site	-	6 - 10	0 / 9	4.2	4.18	.44	10.64	5.44
Up-Gradient	6.6[a] - 6.6[a]	6 - 10	1 / 6	3.95	3.8	1.32	33.42	8.14

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[a]Estimated value.

Group Statistics for Surface Water Samples Collected
November 1992 through May 1994

Cr in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	4.6[a] - 26.3	3 - 6	20 / 144	5.1	4.71	1.68	33.01	8.59
On-Site	-	3 - 6	0 / 25	2.02	2.01	.04	2.21	2.14
Up-Gradient	4.9[a] - 4.9[a]	3 - 6	1 / 22	1.98	1.95	.31	15.98	2.75

Cu in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	3.3[a] - 10.7[a]	2 - 5	40 / 144	2.51	2.47	.45	18	3.45
On-Site	3.1[a] - 65.1	2 - 5	7 / 25	6.36	4.27	6.56	103.13	24.61
Up-Gradient	10.1[a] - 10.1[a]	2 - 5	1 / 22	1.96	1.58	1.72	87.92	6.18

F in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	75.7[a] - 267	-	144 / 144	136.95	136.9	3.6	2.62	144.4
On-Site	82.0[a] - 1070	-	25 / 25	269.56	210.55	214.71	79.65	866.48
Up-Gradient	78.7[a] - 364	-	22 / 22	190.62	170.83	103.41	54.25	443.99

Fe in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	62.2[a] - 4450	-	144 / 144	1004.78	859.89	424.25	42.22	1882.99
On-Site	52.1[a] - 1400	-	25 / 25	480.58	417.6	297.15	61.83	1306.67
Up-Gradient	9.5[a] - 1670	-	22 / 22	715.97	494.67	641.13	89.54	2286.74

[a]Estimated value.

Group Statistics for Surface Water Samples Collected
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Hg   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	-	.1 - .1	0 / 96	.05	.04	0	0	.05
On-Site	0.20[a] - 0.20[a]	.1 - .1	1 / 17	.05	.05	.01	23.95	.09
Up-Gradient	-	.1 - .1	0 / 13	.05	.04	0	0	.05

K   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	1530 - 14400	-	144 / 144	4156.73	4147.76	287.28	6.91	4751.41
On-Site	1000 - 62100	-	25 / 25	12632.5	7673.7	13349.71	105.67	49744.7
Up-Gradient	850[a] - 9800	740 - 1700	16 / 22	4030.25	2435.23	3790.07	94.04	13315.93

Mg   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	5840 - 58000	-	144 / 144	34029.99	33764.64	4550.22	13.37	43448.96
On-Site	17900 - 63800	-	25 / 25	43639.99	43365.95	5518.62	12.64	58981.77
Up-Gradient	7800 - 58300	-	22 / 22	29581.19	27222.34	12751.24	43.1	60821.74

Mn   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	27.7 - 460	-	144 / 144	183.89	182.86	21.08	11.46	227.53
On-Site	24.3 - 785	-	25 / 25	167.59	126.86	111.49	66.52	477.53
Up-Gradient	1.4[a] - 1000	-	22 / 22	266.01	102.37	375.51	141.16	1186.02

[a]Estimated value.

Group Statistics for Surface Water Samples Collected
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Mo   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	1.4[a] - 90.9	22 - 27	97 / 144	13.88	13.14	5.22	37.66	24.7
On-Site	1.2[a] - 2450	22 - 27	18 / 25	174.97	45.4	266.73	152.44	916.48
Up-Gradient	1.3[a] - 20.2[a]	1 - 27	11 / 22	9.97	9.46	3.4	34.16	18.32

NH4 in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	14 - 145	-	144 / 144	57.19	56.83	7.14	12.48	71.97
On-Site	18.0[a] - 258	-	25 / 25	92.34	80.56	54.1	58.59	242.75
Up-Gradient	16.8[a] - 3990	-	22 / 22	665.81	140.63	1470.39	220.84	4268.28

NO2 in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	6.1[a] - 63.4[a]	6 - 6	75 / 96	11.04	8.45	9.78	88.63	31.3
On-Site	16.4[a] - 86.8[a]	6 - 8	15 / 17	38.9	31.3	27.08	69.61	114.18
Up-Gradient	2.1[a] - 30.2[a]	6 - 6	12 / 13	15.68	13.74	9.81	62.54	46.88

NO3 in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	49.2[a] - 6190	-	96 / 96	746.99	328.08	1061	142.03	2943.27
On-Site	34.7[a] - 18500	-	17 / 17	5520.47	1970.28	5704.99	103.34	21380.36
Up-Gradient	50.6[a] - 24600	-	13 / 13	4337.3	1005.46	7711.13	177.78	28858.72

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[a]Estimated value.

Group Statistics for Surface Water Samples Collected
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NO3+NO2-N in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	18.0[a] - 1840	-	48 / 48	226.18	46.55	410.61	181.53	1076.15
On-Site	11.5[a] - 5950	-	8 / 8	1750.34	422.79	2438.97	139.34	8530.67
Up-Gradient	21.8[a] - 1580	-	9 / 9	492.08	284.19	475.74	96.67	1714.74

Na in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	5280 - 170000	-	144 / 144	79772.49	79661.62	4298.35	5.38	88670.09
On-Site	15800 - 1060000	-	25 / 25	151559.99	106304.63	133352.17	87.98	522279.03
Up-Gradient	8390 - 203000	-	22 / 22	81198.8	54089.18	80026.14	98.55	277262.85

Ni in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	6.8[a] - 11.6[a]	6 - 14	37 / 144	6.39	6.34	.75	11.78	7.95
On-Site	9.1[a] - 11.4[a]	6 - 14	2 / 25	5.22	5.19	.65	12.61	7.06
Up-Gradient	10.0[a] - 13.3[a]	6 - 14	3 / 22	4.98	4.58	2.21	44.43	10.4

Pb in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	1.0[a] - 6.5	1 - 1	78 / 144	2.12	1.88	.79	37.21	3.76
On-Site	1.3[a] - 5.1	1 - 1	8 / 25	1.15	1.08	.39	34.22	2.25
Up-Gradient	1.1[a] - 24.5	1 - 1	9 / 22	1.91	1.42	1.63	85.53	5.93

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[a]Estimated value.

Group Statistics for Surface Water Samples Collected
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Pb210 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	2 - 2.7	2 - 2	20 / 120	1.17	1.17	.08	7.55	1.36
On-Site	4.6 - 33.8	2 - 2	5 / 20	5.48	2.65	6.78	123.81	24.34
Up-Gradient	-	2 - 2	0 / 20	1	1	0	0	1

Po210 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	-	.07 - 1.08	0 / 144	.12	.12	.02	23.92	.18
On-Site	0.65 - 0.65	.11 - .83	1 / 25	.18	.17	.06	33.72	.36
Up-Gradient	0.14 - 0.19	.08 - .98	2 / 22	.12	.1	.07	63.52	.31

Ra226 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	0.2 - 1.3	.04 - 1.2	104 / 144	.3	.26	.2	68.04	.72
On-Site	0.16 - 9.10	.15 - .22	21 / 25	2.43	1.38	2.49	102.51	9.36
Up-Gradient	0.1 - 2.35	.07 - .58	10 / 22	.58	.32	.79	136.86	2.53

Ra228 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	-	1 - 5	0 / 144	.9	.89	.17	19.57	1.27
On-Site	-	1 - 9	0 / 25	1.63	1.59	.4	24.78	2.76
Up-Gradient	-	1 - 4	0 / 22	1.15	1.13	.24	21.49	1.76

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[a]Estimated value.

Group Statistics for Surface Water Samples Collected
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Rn222 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	3[a] - 1699	45 - 90	66 / 144	70.69	48.14	106.91	151.22	292
On-Site	63 - 4624	71 - 71	24 / 25	1109.02	614.09	1171.9	105.66	4366.91
Up-Gradient	37[a] - 1550	36 - 129	10 / 22	265.4	120.24	332.14	125.14	1079.16

SO4 in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	46400 - 787000	-	144 / 144	385105.55	376894.84	87545.12	22.73	566323.95
On-Site	222000 - 1380000	-	25 / 25	600493.33	574400.06	182277.79	30.35	107225.6
Up-Gradient	25600 - 1000000	-	22 / 22	223611.9	144361.24	218112.18	97.54	757986.75

Sb in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	1.1[a] - 1.9[a]	1 - 1	37 / 96	.73	.72	.12	17.03	1
On-Site	1.1[a] - 2.2[a]	1 - 1	5 / 17	.8	.75	.33	41.46	1.73
Up-Gradient	1.0[a] - 2.0[a]	1 - 1	4 / 13	.79	.76	.21	26.73	1.46

Se in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	2.0[a] - 19.6	2 - 3.3	75 / 144	2.34	2.17	1.18	50.69	4.8
On-Site	2.5[a] - 540	2 - 15	23 / 25	38.01	15	60.7	159.69	206.76
Up-Gradient	1.8[a] - 9.7	2 - 3	11 / 22	2.23	2.18	.51	23.04	3.49

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[a]Estimated value.

Group Statistics for Surface Water Samples Collected
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Sr in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	358 - 2560	-	96 / 96	1284.62	1264.01	251.82	19.6	1805.9
On-Site	1030 - 2990	-	17 / 17	1956.33	1933.02	339.62	17.36	2900.47
Up-Gradient	318 - 3490	-	13 / 13	1398.66	1201.13	857.64	61.31	4125.98

TDS in mg/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	168[a] - 1630	-	144 / 144	911.88	900.93	153.06	16.78	1228.73
On-Site	542 - 3690	-	25 / 25	1380.17	1342.25	370.36	26.83	2409.79
Up-Gradient	244[a] - 1842	-	22 / 22	886.76	828.61	337.98	38.11	1714.81

Temp in deg C

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	2.7 - 20.8	-	144 / 144	10.64	10.5	1.6	15.1	13.97
On-Site	3.3 - 24.1	-	25 / 25	10.52	10.36	2.08	19.85	16.33
Up-Gradient	1.2 - 18.4	-	22 / 22	9.7	9.19	3.95	40.8	19.39

Th230 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	0.13 - 0.58	.08 - .98	23 / 144	.12	.11	.06	52.85	.25
On-Site	0.36 - 0.81	.05 - 8.93	4 / 25	.54	.29	.73	135.52	2.57
Up-Gradient	0.20 - 0.20	.06 - .3	1 / 22	.07	.06	.02	34.28	.13

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[a]Estimated value.

Group Statistics for Surface Water Samples Collected
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Th232 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	0.09 - 0.09	.05 - .92	1 / 144	.08	.08	.03	44.49	.16
On-Site	-	.05 - 5.31	0 / 25	.33	.18	.46	137.98	1.63
Up-Gradient	0.09 - 0.09	.04 - .3	1 / 22	.06	.05	.02	41.42	.12

Tl in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	-	1 - 2	0 / 144	.58	.57	0	0	.58
On-Site	-	1 - 2	0 / 25	.6	.59	.02	3.33	.65
Up-Gradient	-	1 - 2	0 / 22	.57	.56	.08	15.63	.79

U in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	20.8 - 508	1 - 1	126 / 144	93.56	82.13	55.67	59.5	208.81
On-Site	8.3 - 3230	-	25 / 25	652.12	245.87	1014	155.49	3471.05
Up-Gradient	1.0[a] - 103	1 - 1	17 / 22	19.83	8.63	25.47	128.48	82.25

U234 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	2.42 - 176.51	-	144 / 144	33.9	29.94	19.66	58	74.6
On-Site	5.44 - 1064.78	-	25 / 25	228.25	84	348.76	152.79	1197.83
Up-Gradient	0.77 - 39.30	-	22 / 22	8.33	5.55	8.47	101.7	29.08

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[a]Estimated value.

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U235 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	0.96 - 4.89	.04 - 3.54	61 / 96	1.11	1.09	.16	14.57	1.44
On-Site	0.88 - 42.85	.17 - 2.26	10 / 16	10.55	3.53	14.2	134.55	50.04
Up-Gradient	0.09 - 0.09	.05 - .27	1 / 16	.08	.07	.02	35.04	.15

U238 in pCi/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	1.87 - 174.24	-	144 / 144	33.46	29.5	19.51	58.32	73.86
On-Site	3.59 - 1063.50	-	25 / 25	228.41	80.72	350.66	153.52	1203.28
Up-Gradient	0.36 - 38.07	.28 - .41	19 / 22	6.85	3.55	8.27	120.7	27.12

V   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	6.6[a] - 280	4 - 7	90 / 144	20.84	10.35	34.21	164.17	91.66
On-Site	9.6[a] - 52000	-	25 / 25	3856.25	602.83	5764.6	149.48	19881.86
Up-Gradient	4.6[a] - 29.8[a]	4 - 8	5 / 22	9.3	5.56	10.95	117.67	36.14

Zn   in ug/L

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	3.1[a] - 86.7	7 - 7	125 / 144	24.62	23	7.14	29.02	39.42
On-Site	3.1[a] - 38.3	7 - 7	24 / 25	12.34	12.06	3.07	24.87	20.88
Up-Gradient	4.2[a] - 34.1	3 - 6	20 / 22	11.65	11.11	3.59	30.84	20.46

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[a]Estimated value.

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pH   in

Location	Range of Detected Conc.	Range of Quant. Limits	Frequency of Detection	Average	Geometric Mean	Standard Deviation	Coefficient of Variation	Upper 95% Confidence
Down-Gradient	6.85 - 9.1	-	144 / 144	8.39	8.39	.27	3.23	8.95
On-Site	7.56 - 9.46	-	25 / 25	8.17	8.17	.19	2.42	8.72
Up-Gradient	7.21 - 8.24	-	22 / 22	7.68	7.68	.29	3.87	8.41

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[a]Estimated value.

Appendix D

Monticello Operable Unit III RI/FS Work Plan

Preliminary Human Health Benchmark Calculations

September 1995

DOE-GJPO
RI/FS Work Plan

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DRAFT FINAL

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DRAFT FINAL

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Table 1
Summary of Screening Level Benchmark Concentrations

Chemical Name	Soil Cancer (mg/kg)	Soil Noncancer (mg/kg)	Soil PRG (mg/kg)	Sediment Cancer (mg/kg)	Sediment Noncancer (mg/kg)	Sediment PRG (mg/kg)	Surface Water Cancer (mg/L)	Surface Water Noncancer (mg/L)	Surface Water PRG (mg/L)	Groundwater Cancer (mg/L)	Groundwater Noncancer (mg/L)	Groundwater PRG (mg/L)
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	110	110	--	267399	267399	--	11	11	--	0.01	0.01
Arsenic	0.37	8	0.37	1783	20055	891	0.04	1	0.04	4.9E-05	0.001	4.90E-05
Barium	--	19211	19211	--	46794872	46794872	--	1965	1965	--	2.56	2.56
Beryllium	0.15	1372	0.15	726	3342491	363	0.02	140	0.02	2.0E-05	0.18	2.00E-05
Cadmium (food)	--	274	274	--	668498	668498	--	14	14	--	0.02	0.02
Chromium	--	1372	1372	--	3342491	3342491	--	140	140	--	0.18	0.18
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	10154	10154	--	24734432	24734432	--	1039	1039	--	1.35	1.35
Lead	--	--	1800*	--	--	3253740*	--	--	20*	--	--	0.1*
Manganese (food)	--	38421	38421	--	93589744	93589744	--	140	3931	--	0.18	0.18
Mercury	--	82	82	--	200549	200549	--	8	8	--	0.01	0.01
Nickel	--	5489	5489	--	13369963	13369963	--	562	562	--	0.73	0.73
Selenium	--	1372	1372	--	3342491	3342491	--	140	140	--	0.18	0.18
Silver	--	1372	1372	--	3342491	3342491	--	140	140	--	0.18	0.18
Thallium	--	22	22	--	53480	53480	--	2	2	--	0.003	0.003
Vanadium	--	1921	1921	--	4679487	4679487	--	197	197	--	0.26	0.26
Zinc	--	82331	82331	--	200549451	200549451	--	8423	8423	--	10.95	10.95
Radionuclides (pCi/g or pCi/l)												
Lead-210+D	1.20	NA	1.20	237.06	NA	237.06	56	NA	56	0.07	NA	0.07
Polonium-210	5.27	NA	5.27	1278.78	NA	1278.78	244	NA	244	0.32	NA	0.32
Radium-226+D	0.01	NA	0.01	0.01	NA	0.01	305	NA	305	0.40	NA	0.40
Radium-228+D	0.01	NA	0.01	0.01	NA	0.01	366	NA	366	0.48	NA	0.48
Radon-222+D	0.01	NA	0.01	0.01	NA	0.01	21547	NA	21547	28.01	NA	28.01
Thorium-230	56.57	NA	56.57	767.19	NA	767.19	2818	NA	2818	3.66	NA	3.66
Thorium-232	63.52	NA	63.52	1585.09	NA	1585.09	3053	NA	3053	3.97	NA	3.97
Uranium-234	47.89	NA	47.89	1371.42	NA	1371.42	2289	NA	2289	2.98	NA	2.98
Uranium-235+D	0.17	NA	0.17	0.17	NA	0.17	2289	NA	2289	2.98	NA	2.98
Uranium-238+D	0.80	NA	0.80	0.82	NA	0.82	1832	NA	1832	2.38	NA	2.38

*Values estimated using EPA's Integrated Exposure Uptake Biokinetic Model (EPA, 1994)

Table 2
Toxicity Factors

Chemical Name	Oral SF kg-day/mg	Oral Rfd mg/kg-day
Aluminum	--	--
Antimony	--	0.0004
Arsenic	1.75	0.00003
Barium	--	0.07
Beryllium	4.3	0.005
Cadmium (food)	--	0.001
Cadmium (water)	--	0.0005
Chromium	--	0.005
Cobalt	--	--
Copper	--	0.037
Lead	--	--
Manganese (food)	--	0.14
Manganese (water)	--	0.005
Mercury	--	0.0003
Molybdenum	--	0.005
Nickel	--	0.02
Selenium	--	0.005
Silver	--	0.005
Thallium	--	0.00008
Vanadium	--	0.007
Zinc	--	0.3

	ing*	ext**
Lead-210+D	6.60E-10	1.60E-10
Polonium-210	1.50E-10	2.90E-11
Radium-226+D	1.20E-10	6.00E-06
Radium-228+D	1.00E-10	2.90E-06
Radon-222+D	1.70E-12	5.90E-06
Thorium-230	1.30E-11	5.40E-11
Thorium-232	1.20E-11	2.60E-11
Uranium-234	1.60E-11	3.00E-11
Uranium-235+D	1.60E-11	2.40E-07
Uranium-238+D	2.00E-11	5.10E-08

*risk/PCi **risk/yr per Pci/g

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Table 3
Ingestion of Soil - Cancer-based

Chemical Name	Soil (cancer) (mg/kg)
Aluminum	--
Antimony	--
Arsenic	0.37
Barium	--
Beryllium	0.15
Cadmium (food)	--
Chromium	--
Cobalt	--
Copper	--
Lead	--
Manganese (food)	--
Mercury	--
Molybdenum	--
Nickel	--
Selenium	--
Silver	--
Thallium	--
Vanadium	--
Zinc	--

TR	unitless	0.000001
EF	days/year	350
ED	years	30
AT	years	70
IF	mg-year/kg	114
CF	kg/mg	0.000001

IF	mg-yr/day	3600
Se	unitless	0.2
Te	unitless	1

Radionuclides (pCi/g)

Lead-210+D	1.20E+00
Polonium-210	5.27E+00
Radium-226+D	6.94E-03
Radium-228+D	1.43E-02
Radon-222+D	7.06E-03
Thorium-230	5.66E+01
Thorium-232	6.35E+01
Uranium-234	4.79E+01
Uranium-235+D	1.73E-01
Uranium-238+D	8.01E-01

Chemical Equation:

$$TR \times AT \times 365 / EF \times SFo \times CF \times IF$$

Rad Equation:

$$TR / ((EF \times SFo \times 0.001 \text{ g/mg} \times IF) + (SFe \times ED \times (1-Se) \times Te))$$

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Table 4
Ingestion of Soil - Noncancer-based

Chemical Name	Soil (noncancer) (mg/kg)
Aluminum	--
Antimony	109.77
Arsenic	8.23
Barium	19210.53
Beryllium	1372.18
Cadmium (food)	274.44
Chromium	1372.18
Cobalt	--
Copper	10154.14
Lead	--
Manganese (food)	38421.05
Mercury	82.33
Molybdenum	1372.18
Nickel	5488.72
Selenium	1372.18
Silver	1372.18
Thallium	21.95
Vanadium	1921.05
Zinc	82330.83

THI	unitless	1
ATn	years	30
EF	days/year	350
ED	years	30
IF	mg-yr/kg-day	114
BW	kg	70
CF	10-6 kg/mg	0.000001

Chemical Equation:

THI x AT x 365 / EF x 1/RfDo x CF x IF

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Table 5
Ingestion of Sediment - Cancer-based

Chemical Name	Sediment (cancer) (mg/kg)
Aluminum	--
Antimony	--
Arsenic	1782.66
Barium	--
Beryllium	725.50
Cadmium (food)	--
Chromium	--
Cobalt	--
Copper	--
Lead	--
Manganese (food)	--
Mercury	--
Molybdenum	--
Nickel	--
Selenium	--
Silver	--
Thallium	--
Vanadium	--
Zinc	--

TR	unitless	0.000001
ATc	years	70
EF	days/year	7
ED	years	30
ET	hours/day	2.6
CRsed	mg/hour	1.05
BW	kg	70
CF	10-6 kg/mg	0.000001

Se	unitless	0.2
Te	unitless	1

Radionuclides (pCi/g)

Lead-210+D	2.37E+02
Polonium-210	1.28E+03
Radium-226+D	6.94E-03
Radium-228+D	1.44E-02
Radon-222+D	7.06E-03
Thorium-230	7.67E+02
Thorium-232	1.59E+03
Uranium-234	1.37E+03
Uranium-235+D	1.74E-01
Uranium-238+D	8.17E-01

Chemical Equation:

$$TR \times AT \times 365 \times BW / CRsed \times ET \times EF \times ED \times SFo \times CF$$

Rad Equation:

$$TR / ((EF \times SFo \times 0.001 \text{ g/mg} \times ED \times CRsed \times ET) + (SFe \times ED \times (1-Se) \times Te))$$

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Table 6
Ingestion of Sediment - Noncancer-based

Chemical Name	Sediment (Noncancer) (mg/kg)
Aluminum	--
Antimony	267399.27
Arsenic	20054.95
Barium	46794871.79
Beryllium	3342490.84
Cadmium (food)	668498.17
Chromium	3342490.84
Cobalt	--
Copper	24734432.23
Lead	--
Manganese (food)	93589743.59
Mercury	200549.45
Molybdenum	3342490.84
Nickel	13369963.37
Selenium	3342490.84
Silver	3342490.84
Thallium	53479.85
Vanadium	4679487.18
Zinc	200549450.55

THI	unitless	1
ATn	years	30
EF	days/year	7
ED	years	30
CRsed	mg/hour	2.1
ET	hours/day	2.6
BW	kg	70
CF	10-6 kg/mg	0.000001

Chemical Equation:

THI x AT x 365 x BW / CRsed x ET x EF x ED x 1/RfDo x CF x IF

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Table 7
Ingestion of Surface Water - Cancer-based

Chemical Name	Surface Water Cancer (mg/L)
Aluminum	--
Antimony	--
Arsenic	3.7E-02
Barium	--
Beryllium	1.5E-02
Cadmium (water)	--
Chromium	--
Cobalt	--
Copper	--
Lead	--
Manganese (water)	--
Mercury	--
Molybdenum	--
Nickel	--
Selenium	--
Silver	--
Thallium	--
Vanadium	--
Zinc	--

Radionuclides (pCi/l)

Lead-210+D	56
Polonium-210	244
Radium-226+D	305
Radium-228+D	366
Radon-222+D	21547
Thorium-230	2818
Thorium-232	3053
Uranium-234	2289
Uranium-235+D	2289
Uranium-238+D	1832

TR	unitless	0.000001
ATc	years	70
EF	days/year	7
ED	years	30
CRw	L/hour	0.05
ET	hours/day	2.6
BW	kg	70

Chemical Equation:

$$TR \times BW \times AT \times 365 / CRw \times ET \times EF \times ED \times SFo \times IR$$

Rad Equation:

$$TR / SFo \times EF \times ED \times CRw \times ET$$

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Table 8
Ingestion of Surface Water - Noncancer-based

Chemical Name	Surface Water Noncancer (mg/L)
Aluminum	--
Antimony	11.23076923
Arsenic	0.842307692
Barium	1965.384615
Beryllium	140.3846154
Cadmium (water)	14.03846154
Chromium	140.3846154
Cobalt	--
Copper	1038.846154
Lead	--
Manganese (water)	140.3846154
Mercury	8.423076923
Molybdenum	140.3846154
Nickel	561.5384615
Selenium	140.3846154
Silver	140.3846154
Thallium	2.246153846
Vanadium	196.5384615
Zinc	8423.076923

THI	unitless	1
ATn	years	30
EF	days/year	7
ED	years	30
CRw	L/hours	0.05
ET	hours/day	2.6
BW	kg	70

Chemical Equation:

THI x BW x AT x 365 / CRw x ET x EF x ED x 1/RfDo

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Table 9
Ingestion of Groundwater - Cancer-based

Chemical Name	Groundwater Cancer (mg/L)
Aluminum	--
Antimony	--
Arsenic	4.8667E-05
Barium	--
Beryllium	1.9806E-05
Cadmium (food)	--
Chromium	--
Cobalt	--
Copper	--
Lead	--
Manganese (food)	--
Mercury	--
Molybdenum	--
Nickel	--
Selenium	--
Silver	--
Thallium	--
Vanadium	--
Zinc	--

Radionuclides (pCi/l)

Lead-210+D	0.07215007
Polonium-210	0.31746032
Radium-226+D	0.3968254
Radium-228+D	0.47619048
Radon-222+D	28.0112045
Thorium-230	3.66300366
Thorium-232	3.96825397
Uranium-234	2.97619048
Uranium-235+D	2.97619048
Uranium-238+D	2.38095238

TR	unitless	0.000001
ATc	years	70
EF	days/year	350
ED	years	30
IR	L/day	2
BW	kg	70

Chemical Equation:

TR x BW x AT x 365 / EF x ED x SFo x IR

Rad Equation:

TR / EF x ED x (SFo x IRw)

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Table 10
Ingestion of Groundwater - Noncancer-based

Chemical Name	Groundwater Noncancer (mg/L)
Aluminum	--
Antimony	0.0146
Arsenic	0.001095
Barium	2.555
Beryllium	0.1825
Cadmium (water)	0.01825
Chromium	0.1825
Cobalt	--
Copper	1.3505
Lead	--
Manganese (water)	0.1825
Mercury	0.01095
Molybdenum	0.1825
Nickel	0.73
Selenium	0.1825
Silver	0.1825
Thallium	0.00292
Vanadium	0.2555
Zinc	10.95

THI	unitless	1
ATn	years	30
EF	days/year	350
ED	years	30
IR	L/day	2
BW	kg	70

Chemical Equation:

$$THI \times BW \times AT \times 365 / EF \times ED \times 1/RfDo \times IR$$

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Table 11
Ingestion of Beef Muscle and Liver - Cancer-based

Chemical Name	Beef Tissue (cancer) (mg/kg)	Beef Liver (cancer) (mg/kg)
Aluminum	--	--
Antimony	--	--
Arsenic	2.43E-03	8.11E-03
Barium	--	--
Beryllium	9.90E-04	3.30E-03
Cadmium (food)	--	--
Chromium	--	--
Cobalt	--	--
Copper	--	--
Lead	--	--
Manganese (food)	--	--
Mercury	--	--
Molybdenum	--	--
Nickel	--	--
Selenium	--	--
Silver	--	--
Thallium	--	--
Vanadium	--	--
Zinc	--	--

TR	unitless	0.000001
ATc	years	70
EF	days/year	350
ED	years	30
IR	mg DW/day	40000
	liver	12000
BW	kg	70
CF	10-6 kg/mg	0.000001

Se	unitless	0.2
Te	unitless	1

Radionuclides (pCi/g)

Lead-210+D	3.61E-03	1.20E-02
Polonium-210	1.59E-02	5.29E-02
Radium-226+D	5.14E-03	6.61E-02
Radium-228+D	8.96E-03	7.94E-02
Radon-222+D	7.03E-03	4.67E+00
Thorium-230	1.83E-01	6.11E-01
Thorium-232	1.98E-01	6.61E-01
Uranium-234	1.49E-01	4.96E-01
Uranium-235+D	8.01E-02	4.96E-01
Uranium-238+D	1.04E-01	3.97E-01

Chemical Equation:

TRx AT x 365 x BW / CRsed x ET x EF x ED x SFo x CF

Rad Equation:

TR / ((EF x SFo x 0.001 g/mg x ED x IR) + (SFe x ED x (1-Se) x Te))

Table 12

Ingestion of Beef Muscle and Liver - Noncancer-based

Chemical Name	Beef Tissue (cancer) (mg/kg)	Beef Liver (cancer) (mg/kg)
Aluminum	--	--
Antimony	36.50	121.67
Arsenic	2.74	9.13
Barium	6387.50	21291.67
Beryllium	456.25	1520.83
Cadmium (food)	91.25	304.17
Chromium	456.25	1520.83
Cobalt	--	--
Copper	3376.25	11254.17
Lead	--	--
Manganese (food)	12775.00	42583.33
Mercury	27.38	91.25
Molybdenum	456.25	1520.83
Nickel	1825.00	6083.33
Selenium	456.25	1520.83
Silver	456.25	1520.83
Thallium	7.30	24.33
Vanadium	638.75	2129.17
Zinc	27375.00	91250.00

THI	unitless	1
ATn	years	30
EF	days/year	7
ED	years	30
IR	mg DW/day	40000
	liver	12000
BW	kg	70
CF	10-6 kg/mg	0.000001

Chemical Equation:

THI x AT x 365 x BW / CRsed x ET x EF x ED x 1/RfDo x CF x IF

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Appendix E

Monticello Operable Unit III RI/FS Work Plan

Responses to Regulatory Comments
on the March 1995 Revised Draft Work Plan,
Field Sampling Plan, and Quality Assurance Project Plan

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MONTICELLO OU III RI/FS WORK PLAN

RESPONSES TO REGULATORY COMMENTS

General Comments

The format utilized, which separated tables and figures from the text made it extremely difficult to remain focused on the work plan. In many instances a single page table or figure would have been more appropriate within the text.

There are a number of previous studies and investigations identified in Volume I, Section 2; however, in many instances it is unclear what significance or importance should be given to the report. A concise summary of what was learned from the study or how it fits into the present RI/FS would have been helpful.

DOE has used a number of acronyms and has included a list of acronyms utilized in the documents; however, the document leaves undefined a number of terms which should probably be included in a table of terms and definitions or at a minimum be defined the first time that they appear in each document. EPA would suggest that the use of acronyms be minimized as it is difficult for the lay reader to follow.

We have included a number of comments on ground water monitoring which we hope will help to simplify and focus the modeling effort on those areas which we believe are most important. The ground-water modeling should not be the desired objective. Ground-water modeling and contaminant transport modeling is used as a tool to aid in understanding the ground-water flow system and distribution and movement of contaminants at a site. The results from the ground-water modeling effort, are used to assist the decision makers (risk managers) in arriving at a remedy which is protective of human health and the environment. Any data collected should be data used to gain a better understanding of the ground-water flow system in general.

Response

Par. 1   *The format of the Work Plan has been revised. One- and two-page tables and figures are presented within the text. Tables present on more than two pages and all oversize tables and figures are placed at the end of the section in which they are first referenced.*

Par. 2   *A concise summary of each previous investigation and study discussed in the document has been prepared and included in the draft final Work Plan.*

Par. 3   *The text has been revised as appropriate to ensure that potentially confusing terms are clearly defined the first time they appear in each document.*

Par. 4   *The scope of the ground-water modeling effort has been revised in accordance with technical discussions conducted among DOE, EPA, and UDEQ in August 1995.*

Specified Comments

Comment 1

Section 1.0, Introduction, page 1-2, 2nd bullet. Terminology has not been clearly defined at this point in the text which makes this reference to the upper ground-water flow system. Does reference to the "upper ground-water flow system" mean shallow in quaternary and upper Mancos shale? Please delete the part of the last sentence which states "upon which the need for remedial action will be assessed". Risk based levels will not be the only factor in determining whether or not there is a need for remedial action.

Response

a. *The upper flow system is defined in Section 3.4.1 as follows:*

> *"The upper ground-water flow system , also referred to as the "alluvial aquifer", consists of the saturated Quaternary deposits and the upper, weathered portion of underlying bedrock." [Note: the word "mostly" was deleted after the word "consists"]*
>
> *The term "alluvial aquifer" would therefore be incomplete as the aquifer includes weathered portions of the underlying bedrock units that subcrop against the Quaternary deposits. From west to east, the underlying bedrock units consist of the Mancos Shale, Dakota Sandstone, Burro Canyon Formation, and the Brushy Basin Member of the Morrison Formation.*

b. *The last sentence has been modified as suggested.*

Comment 2

Section 1.1 objectives, page 1-3, 2nd paragraph. It is unclear whether the goal(s) identified are consistent with the purpose of an RI/FS. Furthermore, we are uncertain as to whether a clear distinction can be made in the risk assessment to differentiate whether the risk comes from the contaminated soil or from the surface and ground water. Please clarify what is meant by "sufficient quality data"? If this is discussed further along in the document, that should be stated here. Otherwise, this is a vague term.

Response

The goals identified in this paragraph are consistent with the purpose of an RI/FS in "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA 540-G-89-004, OSWER Directive 9355-3-0, October, 1988). "The objective of the RI/FS process in not the unobtainable goal of removing all uncertainty, but rather to gather information sufficient to support an informed risk management decision regarding which remedy appears to be most appropriate for a given site." All three goals listed in the second paragraph of page 1-3 are focused on providing sufficient information for risk management decisions without over characterizing the site.

The data that will be used to estimate risks will be organized by media. Exposures and risks will be estimated for each relevant pathway and the associated media, as required by U.S. EPA Guidance (EPA/540/1-89-002). Because sufficient data will be available when the risk assessment is done and the conceptual site model identifies clear and distinct pathways, it will be possible to identify if the risk originates from contaminated soil or from contaminated surface or ground water. Furthermore, this will be critical input to the Feasibility Study to support any remediation that may be necessary. "Sufficient data quality" refers to the RI/FS objective of "...[not] removing all uncertainty but rather to gather information sufficient to support an informed risk management decision..." as stated above. Sufficient quantity and quality of data appropriate for the OU III RI/FS is further defined in the data quality objective sections in Section 4.0 of the Work Plan.

Comment 3

Section 1.1, Objectives, page 1-4. The statement made under the first bullet is correct, however, it should be noted that numeric cleanup criteria (MCLs) already exist for ground water. The goal for cleanup of OU III should be to make certain that the remedy selected is protective of human health and the environment, and to meet all applicable or relevant and appropriate regulations (ARAR's) as necessary. State ground water protection levels (associated MCLs) is an ARAR. It is only after an exhaustive effort to show that meeting MCLs is impractical that other options are considered. The cleanup of soil and sediment should take into account the ultimate goal of meeting MCLs. Part of the reason for performing risk assessments under CERCLA is the fact that there are no soil cleanup standards in place (as there are for ground water) so, consequently those levels are, in part, determined using a site specific risk assessment. The regulatory standards which are already established make up the other part for determining soil cleanup standards. It is evident throughout the report that an assumption is being made that ARAR waivers (alternate concentration levels or supplemental standards) will be easy to acquire. This is not the case. It is possible to acquire an ARAR waiver, but only after first setting a goal and trying to meet the requirements. Please address this issue explicitly somewhere in this section.

Response

The text has been revised as follows:

"The goal of the final remedy will be to meet ARARs. However, if the requirements of the set goal cannot be achieved because of increased environmental damage, technical capability, cost, or other mitigating factors, ARAR waivers (alternative concentration levels or supplemental standards) must be pursued."

Comment 4

Section 1.1, Objectives, page 1-4, 3rd bullet. The stated objective is to "Develop a numerical model that adequately represents surface water and ground water conditions within OU III. The adequacy of the model will be determined on the basis of applicability to the decision-making process.

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The reasons for which the numerical ground-water flow and transport model will be developed should be clear before embarking on that task. The modeler should have a clear understanding of the objectives of the modeling task (how the model will help to answer questions related to ground-water flow and contaminant transport), and a general idea of the degree or extent to which the model should accurately agree with observed data. The numerical ground-water flow model will only model that aspect of the surface conditions that relate directly to the ground-water flow system. This includes surface water boundary conditions and seepage rates between the surface and ground-water system. The seepage rate is dependent on the relationship between the elevation of the surface-water element (stream, river, reservoir, etc.) And the elevation of the ground-water flow system and whether or not there is a hydraulic connection between the two (no separation between bottom of surface-water body and top of ground-water table). The seepage rate is also dependent upon the transmissivity of the media through which the seepage occurs. Information about total flow in a stream can be estimated with some river packages (Stream-flow routing package, MODRVINT) but this information is not necessary for the proposed modeling presented in this document.

Response

The referenced statement has been changed to: "Develop a numerical model that adequately represents ground-water conditions, including ground water and surface water interaction within OU III."

The ground-water model will not model surface water flows and/or contaminant transport. Surface water (Montezuma Creek) exists as a boundary condition which acts as a source to ground water or a sink to ground water. The cumulative amounts of ground-water recharge and discharge as a result of this condition (stream) can be determined in model output, but the actual volume of flow in the stream is not computed.

Comment 5

Section 1.2. Technical Approach. Step 1. page 1-4. This paragraph does not clearly and succinctly identify the primary decision points in the RI/FS. If they are not to be identified in this section of the text please indicate where they are within the work plan.

Response

The following has been inserted at the end of Step 1 in Section 1.2: "The first decision to be made will be whether or not there is an unacceptable current or future risk to human health or the environment. The second decision will be whether or not there is sufficient information to proceed into the EE/CA to address that risk, while supporting the final remedy which will meet proposed ARARs. The third decision will be whether or not proposed ARARs can be cost-effectively satisfied by the early action. The fourth decision will be whether or not the final remedy can meet ARARs. If as part of the forth decision it is determined that ARARs cannot be practicably met, the fifth decision will be whether or not some alternative remedy requirement other than ARAR waivers are appropriate."

Comment 6

Section 1.2, Technical Approach, page 1-5. The discussion given under "Sediment and Soil Contaminant Source" is somewhat misleading. Please refer to comment #2 and address the same issue here.

Response

See the response to comment #5 and the new Work Plan language presented in the response to comment #2.

Comment 7

Section 1.2, Technical Approach, page 1-6. Once again, please address the same issue presented in comment #2 under "Surface-Water and Ground-Water Contaminant Source". For example, the first decision to be made should be whether or not there is unacceptable risk. If the risk is unacceptable then a risk management decision will need to be made as to whether, proposed ARARs can be satisfied. If they can, then that should be the goal and actions should be taken accordingly. In the event that meeting an ARAR requirement is not practical because of increased environmental damage, technical capability, or cost, etc., an application may be made for an ARAR waiver (e.g., alternative concentration levels or supplemental standards). However, it is still not automatic that an ARAR waiver will be granted. Alternate requirements may be allowed which may require some form of remedial action.

Response

See new Work Plan language presented in responses to comments #2 and #5.

Comment 8

Section 1.2, Technical Approach, paragraph 3, page 1-6. Paragraph three states that "Surface-Water and ground-water Contaminant Source Evaluation of the no-action alternative will include assessment of ground-water model predictions regarding the length of time anticipated for exposure-point concentrations to attain levels protective of human health and the environment and meet other reference criteria."

There are a number of general, undefined terms utilized in this paragraph which must be explained in greater detail (e.g., What exposure-points are being contemplated? What is a reasonable period of time? What is meant by the term "other reference criteria?")

EPA and UDEQ concur that the numerical model can be used to make predictions such as this. However, if the prediction is one that is used in part (EPA and UDEQ have indicated that the model results overtime must be supported by monitoring) to conclude that no-action will be taken and the contamination in the ground-water will be allowed to dissipate naturally, the ground-water flow model results should be evaluated statistically. A 95% confidence interval can be constructed for parameter estimates to demonstrate how reliable the parameter estimate is. If the

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confidence interval is too broad, say for example, over two orders of magnitude for the parameter value, then the estimate of parameters used in the model indicates there is a significant amount of uncertainty associated with the parameter estimate. If the confidence interval is narrower, for example one half order of magnitude of the parameter estimate, the parameter estimate is considered more reliable.

Those confidence intervals can be calculated by first using MODFLOWP and the public domain program BCINT (designed to calculate these confidence intervals for parameter estimates) to be used with MODFLOWP results. Even if a deterministic calibration is done initially, the final results can be run through MODFLOWP to get the necessary information about parameter estimates. Model results can be evaluated statistically and the predictions made with the transport model can be evaluated more objectively.

Response

Par. 1   No response required.

Par. 2a   *The text has been revised to clarify that "exposure-point concentrations" refer to the location where a future house will be constructed. It is anticipated that this would occur outside of the floodplain along upper Montezuma Creek.*

Par. 2b   *Promulgations are silent regarding explicit 'reasonable times' for cleanup. The NCP does not specify what is a 'reasonable time' for groundwater or surface water cleanup, though the requirement for protection of human health and the environment relies upon the lead agency to implicitly determine a reasonable time (ie: when acceptable risks are exceeded).*

It has not been determined that surface water or groundwater contamination presents a current or imminent threat to human health or the environment in Montezuma Creek canyon. Future risk exceedances associated with both surface water and groundwater in the upper and/or lower portion of Montezuma Creek canyon are likely and are being assessed as part of the RI. The specific projected future land use under contemplation assumes the Monticello Millsite is remediated and converted to a golf course around which residential development begins to occur by the year 2005.

The Monticello Millsite (OU I) Record of Decision (ROD) implies one promulgated 'reasonable time' for groundwater restoration with the citation of the 'to be considered' (TBC) 40 CFR Part 192 (a)(2) and (3). Based on this regulation the January, 1990, OU I Feasibility Study stated: "For aquifers where passive restoration of contaminated groundwater is projected to occur within 100 years and where groundwater is not now used and is not projected to be used for a public water supply during that period, active remediation may be avoided if there are satisfactory institutional controls which will effectively protect public health and satisfy beneficial uses of the groundwater" (page 4-59).

This TBC may not be trenchant at OU III, given likely, and eminent, future

*residential land use, particularly in the upper portion of the canyon. Further, this
OU I groundwater TBC does not take into account OU III surface water. While
Millsite cleanup will probably reduce the current significant source of contamination
in Montezuma Creek, interaction with contaminated groundwater undergoing the
passive remediation discussed above may not assure timely, unrestricted surface
water use, especially for any upper canyon residents.*

*Therefore, lacking a firm definition of 'reasonable time', though provided adequate
published guidance and reference on the development of such a determination, DOE
will propose in the Work Plan the determination methodology. This methodology will
incorporate, for both surface water and groundwater, relevant factors such as:*

> *1. land use(s) in the upper and lower Montezuma Creek canyon;*
>
> *2. point of compliance;*
>
> *3. contaminant-specific cleanup criteria (ARARs, risk, etc);*
>
> *4. exposure point concentrations (ecologic, human health, and food chain
> uptake); and,*
>
> *5. availability and adequacy of alternative control measures such as institutional
> controls.*

Par. 2c   *The text has been revised to clarify that "reference criteria" refer to MCLs, ARARs,
TBCs, background concentrations, and risk-based concentrations.*

Par. 3&4   *The DOE agrees that should the ground-water modeling predictions be used to
support a no action remedial alternative for OU III, the uncertainty of the model
input parameters must be vigorously assessed, and the model must be sufficiently
defensible to all risk managers.*

Comment 9

Section 1.2, Technical Approach, Step 4, page 1-7, 1st paragraph. It would seem that since the
ARARs applicable to OU III have been identified (the 1990 Record of Decision of Operable
Unit I and II) and therefore the use of the work "preliminary" in this context is inappropriate.
Please address the issue raised in comments # 3.

Response

*See new Work Plan language presented in response to comment #3. In additions, DOE will
identify any pertinent ARARs not specified in the OU I Record of Decision.*

Comment 10

Section 2.1.1. Historical Investigations, page 2-2. Please be consistent when writing numbers explaining concentrations. For example, in the second paragraph of this page the concentration of vanadium is given as 65 to 85 ppm and the concentration of arsenic is given as four to six ppm. Although technically correct it would be useful to have the number in parentheses following the word. It appears that this is the only section with this problem.

Response

A consistent format was used to display concentration values in the draft final Work Plan.

Comment 11

Section 2.1.2.2. page 2-4. The "1984" in the heading should be changed to 1994. Please make the change.

Response

The text has been revised as requested.

Comment 12

Section 2.1.2.2. page 2-4. "The main stem of Montezuma Creek shows little evidence of large floods in recent years. . . Verdure Creek apparently has undergone such a flood in the past few decades. . ."

Please clarify what is meant by "large floods", "recent years" and a "few" decades.

Response

The text has been revised to indicate that "large floods" refers to discharges of greater than 500 cfs, "recent years" refers to the past 10 years, and "few decades" refers to 40 or 50 years.

Comment 13

Section 2.1.2.2. page 2.7. "In 1982, 32 monitoring wells were installed in the upper ground-water flow system; 10 of these wells were screened between the upper flow system and Mancos Shale or the upper flow system and Dakota Sandstone."

Although the term "upper flow system" is generally understood by technical staff working on the Monticello NPL sites the term has been utilized several times in the work plan with no definition or explanation. Please explain the meaning of the term. The confusion arises as a result of referring to "upper flow system and Mancos Shale or upper flow system and Dakota Sandstone". It is not apparent to most lay-readers that the Mancos shale is discontinuous within the Montezuma creek alluvial valley.

Response

The term "upper flow system" has been clarified in the text (see response to comment #1).

Comment 14

Section 2.1.2.2, page 2.8. "(Testing results were reevaluated in 1993 and the bail tests were determined unreliable [Rust Geotech 1993b].)"

The reference listed is an internal memo. Why were the bail tests results considered unreliable? How do the aquifer test results compare with subsequent aquifer tests performed at the site?

Response

The 1983 bail tests are considered unreliable because 1) the method used to monitor and record water-level recovery may not have provided the sensitivity necessary to obtain accurate recovery measurements, 2) the method of analysis used (Hvorslev, 1953), is primarily used for partially penetrating wells in confined aquifers, the Bower and Rice (1976) method for unconfined aquifers would be more appropriate for these data, and 3) several errors were made during the analysis of the data including the effective radius of the casing was not used in place of the measured radius when test recovery was within the filter pack, and the ground surface was used for the top of the aquifer instead of the water table elevation (Rust Geotech 1993b). Unfortunately, the raw data could not be located so the tests could be reanalyzed using more correct methods.

Comment 15

Section 2.2.2.1, Historical Investigations, page 2-10. In the first sentence of the first paragraph it states that Montezuma Creek flows through the millsite from east to west. Montezuma Creek does not flow from east to west but from west to east. Please make this change.

Response

The text has been revised as requested.

Comment 16

Section 2.3.2.2, page 2-12. "Flow records indicate that runoff increases in March and decreases in June. By July, the discharge is usually at base flow."

What are all the sources of flow into Montezuma Creek? Is the amount of water in Montezuma Creek controlled by discharges from Lloyd's lake? Understanding the sources of water for Montezuma Creek and what portion of flow relates to surface water/ground-water interaction is an important component of the water budget for the area. As presently outlined, these questions need to be answered in the RI as they may be critical to the question of whether the upper flow

system will cleanup in a "reasonable amount of time". Furthermore, please clarify what DOE considers to be a reasonable amount of time?

Response

a. *Section 3.4 discusses the gains and losses of Montezuma Creek. The main sources of flow to Montezuma Creek upstream and on the millsite are South Creek, the North Creek, and ground-water seepage. The main nearby sources downstream of the millsite include intermittent flow from North Creek and Vega Creek. South Creek receives a relatively small and constant amount of flow from leakage of Lloyd's Lake Dam. North Creek originates west of Monticello in North Canyon in the Abajo Mountains. A significant portion of North Creek's flow is diverted several miles west of Monticello into the "North Creek Diversion" drainage. North Creek Diversion water is used to irrigate crops north and northeast of Monticello. North Creek Diversion flows (intermittently) into Montezuma Creek downstream of the millsite on the north side of the lower canyon and upstream of Vega Creek confluence.*

South Creek and North Creek join at the public golf course west of Highway 191 and the millsite. Typically, South Creek and North Creek flows above this confluence are small (less than approximately 200 gallons per minute) and not easily measurable with the Swoffer flow meter.

b. *Ground-water seepage is visible several places on the banks of the western part of Montezuma Creek, especially on the north bank on the western portion of the millsite.*

c. *See the new Work Plan language presented in response Par. 2.b to comment #8.*

Comment 17

Section 2.3.3. Wetlands, page 2-15. An accurate wetlands assessment should be conducted regardless of whether or not results of the baseline risk assessment show unacceptable risk. There are ARARs which would apply to wetlands. Please revise the test accordingly. Restoration of the millsite following excavation of the tailings and contaminated material as well as any removal of contaminated materials, either through an interim action or decision to remove contaminated material along the stream channel may result in impacts to wetlands. DOE has never conducted a detailed wetlands assessment of the millsite area or of Montezuma Creek. As part of Operable Unit III and the Millsite restoration activities an official wetlands assessment needs to be conducted.

Response

A wetlands assessment was completed within the OU III study area in August 1995. The assessment involved delineation of wetlands along Montezuma Creek.

Comment 18

Section 3.3.4 - Dakota Sandstone, page 3-4. A summary of structural geology of the area including fracture patterns, faults and other pertinent structural geology observations should be included in this section. Fractures, faults and other geologic structures may provide pathways for ground-water flow and contaminant transport.

Response

A short discussion of regional structural geology was added to section 3.3, Geologic Setting. A new section, 3.3.7 Structural Geology, was added to discuss joint and fracture systems in the MMTS area.

Comment 19

Section 3.4.1 - Upper Ground-Water Flow System, page 3-5. ". . the larger transmissivity value is not considered representative of the upper flow system because the test is believed to have been influenced by recharge from Montezuma Creek."

Did drawdown reach Montezuma Creek during the aquifer pumping test? If the drawdown cone reached the creek during the pumping test, then the proximity of the creek to the pumping test may have influenced the results. Was any attempt made to include this factor in the analysis of the pumping test results so that a realistic value of transmissivity could be estimated? Have any recent studies provided additional information on transmissivity?

Response

Drawdown stabilized after a period of time indicating that the drawdown cone intercepted a positive barrier (constant head source). However, preliminary calculations indicated that stabilization occurred earlier in time than what would be expected for when the drawdown cone would reach the stream. The pumping test was conducted in the area of the millsite that has since been interpreted as having increased recharge and/or ground-water flow. The potential sources of recharge include leaking municipal water pipes (some of which have been verified), irrigation associated with the town of Monticello, and leakage from Hall's Ditch. No attempt was made to include this 'factor' into the pumping test analysis (only 0.2 ft of drawdown was observed before the cone stabilized). Pumping of well 88-89 was conducted during the week of July 24, 1995, to provide water to test the water treatment plant. Although a formal pumping test was not planned (this well was also pump-tested in 1988), water levels were recorded in several nearby monitoring wells. The usefulness of the data will be evaluated after the test.

Comment 20

Section 3.4.1 Upper Ground-Water Flow System, page 3-7. "On the basis of ground-water modeling and environmental isotope measurements collected approximately one mile due south of the millsite, surficial recharge to the upper flow system is estimated to be approximately $1X10^{-9}$ to $1X10^{-7}$ cm/s. . ." This range is approximately .001 to .1 ft/yr (.0124 to 1.24 in/yr). How does

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this relate to precipitation in the area (roughly .1% to 10% of annual precipitation)? The water level fluctuations observed in wells completed in the shallow (uppermost) aquifer system after precipitation events indicates a rapid infiltration of surface water into the ground-water system. What statistical confidence can be estimated for the range of recharge values presented here? This estimate is over two orders of magnitude - a wide interval. The implication of this wide range is that a significant amount of uncertainty is associated with the recharge estimate, especially if this is an average yearly estimate of recharge. Fluctuations of water levels in shallow wells in the area indicate a more rapid infiltration when there is precipitation.

Response

The estimates of areal recharge based on ground-water modeling and environmental isotope analysis (1x10^9 to 1x10^8 cm/s or 0.0124 to 1.24 in/yr, respectively) represent approximately 0.08 percent and 8.3 percent of the annual precipitation which is approximately 15 in/yr in Monticello. As stated the estimates of recharge quoted are values of recharge based on groundwater modeling and environmental isotope testing conducted on the south sites. The 1 x 10^7 cm/s value was estimated to be a potential recharge rate for the alluvial sediments in the Montezuma Creek valley. Modeling conducted to date indicate that recharge may be closer to this value, or of the order of 1 to 2 in/yr. The precipitation versus water-level data that DOE has analyzed to date show inconsistent trends. Because the measurement of water levels do not often closely follow precipitation events correlations are difficult to interpret. Some wells appear to show an increase in water levels, presumably because of the precipitation event. Other wells do not show any apparent correlation. No statistical confidence has been estimated for the recharge values given. Recharge is commonly a difficult parameter to estimate. The modeling and isotope values are seen as conservative or lower-end numbers because the surface materials on the south sites are generally finer-grained (loess).

Comment 21

Section 3.4.2 - Mancos Shale and Dakota Sandstone Aquitard, page 3-8. "The Mancos shale and upper and middle Dakota sandstone are believed to act as an aquitard . . ."

The Mancos Shale and Dakota Sandstone have not been established a aquitards. Making this assumption is not a conservative approach to the possibility that contaminants may be able to flow vertically through the Mancos Shale and the Dakota Sandstone and reach the Burro Canyon aquifer.

Response

DEPENDS ON MODELING APPROACH
All available hydrogeologic data indicates that the Mancos Shale and Dakota Sandstone are not good producers of ground water. They are variably saturated (unsaturated in some places). Wells completed in these units yield water very slowly. It takes many hours to days for the wells to recover once they have been purged. The poor water-bearing nature of these units qualifies them to act collectively as an aquitard. The fact that they are referred to as an aquitard does in no way mean that they cannot transmit water and contaminants. It does imply that such

transmission of water and contaminants is relatively slow compared to the aquifers in the area. The presence of fractures and the potential for contaminated ground water to be relatively quickly transported by way of these preferential flow paths is not disputed. However, there is no evidence that continuous fractures of sufficient hydraulic aperture do or do not exist -- this would require and expensive and extensive characterization project.

The vertical matrix flow in the Mancos Shale and Dakota Sandstone is of the order of 10^{-7} to 10^{-9} cm/s. Ground-water flow and contaminant transport under these conditions is extremely slow and modeling of such flow and transport is problematic and not cost effective.

Comment 22

Section 3.4.2 - Mancos Shale and Dakota Sandstone Aquitard, page 3-9. The geometric mean of the hydraulic conductivity for both the Mancos Shale and Dakota Sandstone is approximately 4×10^{-7} cm/s"

Using a geometric mean can be misleading where contaminant transport is concerned because a geometric mean is weighted toward smaller value of hydraulic conductivity. A geometric mean can be used to assess bulk flow through a hydrogeologic unit where overall ground-water flow is being evaluated (average flow per unit area). However, contaminants will most likely migrate along the paths of least resistance through portions of these hydrogeologic units that have a higher value of hydraulic conductivity (such as sandstone and conglomerate deposits in the Dakota Sandstone), or through fractures (vertical and horizontal) and horizontal bedding planes. This possibility is mentioned later in this document where the following statement is made, "Some preferential flow probably occurs in fractures, fractured zones, and/or more conductive layers such as clean sandstones and coal seams." A geometric mean is not an appropriate means of evaluating how the contaminants will flow laterally and vertically. The higher values of reported hydraulic conductivity should be considered for contaminant transport flow to provide a conservative estimate of contaminant flow both laterally and vertically.

Response

DEPENDS ON MODELING APPROACH
The DOE does not argue the fact that the geometric mean favors lower values. The DOE did not use the geometric mean because it favors lower values, it uses the geometric mean because it is an industry standard. A peer review conducted by two independent hydrogeologists/engineers for the OUI repository design, specifically criticized the use of the arithmetic mean, even though it was being used as a conservative approach. The calibrated (note: there are only a few Dakota wells to calibrate to) flow model should help narrow the value of conductivity. Higher values of hydraulic conductivity will be considered and used in the analysis of flow in the Mancos Shale/Dakota Sandstone in the sensitivity analysis.

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Comment 23

Section 3.4.2 - Mancos Shale and Dakota Sandstone Aquitard, page 3-8. "The difference in apparent ages between the Dakota Sandstone and Burro Canyon ground water suggest little-to-no hydraulic communication between these hydrogeologic units."

Results of the age dating of ground-water were inconclusive. These age dating results may even be interpreted to indicate that although significant recharge occurs upgradient where these units are exposed (older waters) some water may migrate vertically from upper hydrogeologic units to lower ones (younger waters).

Response

DEPENDS ON MODELING APPROACH
The DOE does not argue that the tritium results of the radiological isotope age dating study could indicate that some younger waters may have mixed with the older waters of the Dakota Sandstone. However, the data consistently show that the Burro Canyon water is significantly younger than the Dakota Sandstone water (4000 versus 20,000 yrs). This important fact emphasizes that the hydraulic conductivities are orders of magnitude different and/or supports the hypothesis that these waters may originate from different source locations. If significant volumes of the ground waters of the Dakota Sandstone and Burro Canyon were mixing, their relative ages would be closer to the same. In addition, as expected, greater amounts of tritium were present in the shallow zone and upper Mancos Shale ground water, with smaller amounts in the Dakota Sandstone and barely detectable amounts in the Burro Canyon. Of the three Dakota wells tested, two showed concentrations of tritium indicating ages of greater than 35 years (but possibly less than 55 years old). Coincidently these wells also went dry during sampling and had to be repeatedly sampled over a period of hours or days in order to obtain enough sample volume. The repeated sampling could have resulted in sample contamination by atmospheric or 'modern' tritium.

Comment 24

Section 3.4.2 - Burro Canyon Aquifer, paragraph 4, page 3-11. "In cases where the piezometric head in the Burro Canyon aquifer lies above the Burro Canyon Formation contact, the presence of a confining bed is not obvious."

"Potentiometric head" should be used in place of piezometric head where comparison of water elevation between two hydrogeologic units are being made. Potentiometric head include both pressure head plus elevation and therefore reports total potential allowing for comparison of total potential between units. In addition, absence of a confining unit may indicate vertical migration of contaminants in possible.

Response

DEPENDS ON MODELING APPROACH
The apparent absence of a "confining bed" would indicate that vertical migration of

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contaminants is possible. Even if a confining bed were present migration is possible. It would appear that the characteristics that commonly define a confining unit, a clay or shale unit for example, may not always be necessary to confine an aquifer. Subtle cementation in the fine sandstone of the lower Dakota Sandstone may provide sufficient confining conditions (see also response to comment 25 below).

Comment 25

Section 3.4.2 - Burro Canyon Aquifer, paragraph 4, page 3-11. "This information suggests that well to moderately cemented sandstones of the lower Dakota Sandstone form the confining unit above the Burro Canyon aquifer."

The term "well to moderately cemented" is vague. What is the percentage of cement in the lower Dakota Sandstone? A quantitative analysis of this would be more useful to aid in understanding the hydrogeologic behavior of these units. This is especially important because little data has been presented that allows for conclusive evidence that there is no vertical communication between the shallow and deeper ground-water flow system.

Response

DEPENDS ON MODELING APPROACH
The percentage of cement in the lower Dakota Sandstone, or any other portion of the Dakota Sandstone has not been determined. A quantitative analysis of cementation in the Dakota Sandstone could aid in understanding the hydrogeologic behavior of these units. DOE will consider performing such analysis.

Comment 26

Section 4.1, Data Quality Objective Process, page 4-2. In the fifth paragraph of this page please include existing rules and regulations as primary inputs to the decision making process for OU III.

Response

The text has been revised to read - "The primary inputs to the OU III decision-making process include the ecological and human health risk assessments, ground-water modeling, and existing rules and regulations".

Comment 27

Section 4.1, Data Quality Objective Process, page 4-4. "Existing hydrogeologic data, coupled with data obtained from literature, are of sufficient quality and quantity to support ground water modeling. These data will be used as input to the model."

Flow and concentration data, literature review, and any other information related to the ground-water flow system should be used to better understand the ground-water flow system. This information assists the scientist or engineer to achieve one or more (commonly more than a single

working hypothesis) conceptual models of the ground-water flow system. Data collected in the field can be use to estimate parameter values such as transmissivity, recharge, etc. that are part of the input into the ground-water flow and contaminant transport models. The ground-water model, then, can be used a tool to assess the conceptual models. The possible conceptual models can be thought of a multiple working hypotheses. Varying boundary conditions, model parameters and the distribution of parameters over the model (zones of transmissivity, recharge, vertical leakage, etc.) can all be inputed and tested during model calibration. These hypotheses are tested by calculating a sum-of-squares value of potentiometric head observed in the field (water levels in wells) and those values of potentiometric head simulated by the numerical model. This can also be done for flow observations. Distribution concentration of contaminants in the transport model versus what is observed in the field can be used to assess both flow and transport model results.

Response

DOE concurs. The comment reflects the approach of the revised (March 1995) Work Plan.

Comment 28

Section 4.4.2.1 - Field Program, page 4-8. "During drilling of the bedrock wells, 16 core samples were collected from the Dakota Sandstone and the Burro Canyon Formation for vertical conductivity analysis."

Hydraulic conductivity testing on the core samples will only indicate the hydraulic conductivity of the matrix material. Where are these results presented? A brief overview of the values would be useful here, (maximum value, minimum value, arithmetic mean, standard deviation, coefficient of variation, geometric mean). The fracturing that is evident in outcrop in Montezuma Canyon may be an avenue of additional vertical leakage from one hydrogeologic unit to another and should not be discounted as a possible significant component of vertical leakage between units. The core should be slabbed and logged to gain a better understanding of these hydrogeologic units.

Response

DOE recognizes that vertical hydraulic conductivity testing of core samples provides primarily a measurement of the hydraulic conductivity of the matrix material and that flow through fractures may be a component of any vertical leakage between units. Laboratory testing results have not been formerly presented as testing was preformed during baseline characterization of the RI; additional analysis of the core samples (slabbing and logging) is not possible because all core retrieved was consumed during the hydraulic conductivity testing. Text in the draft final RI/FS Work Plan has been revised to contain a brief summary of the results including the values requested.

Comment 29

Section 4.4.2.1 - Field Program, page 4-10. Table 4.4-4 shows iron in the Burro Canyon Aquifer at 690 μg/L upgradient, 340 μg/L at the millsite and 1500 μg/L downgradient from the millsite.

What are some of the possible explanations of increased iron in the Burro Canyon aquifer down-gradient of the site?

Response

Table 4.4-4 of the revised draft RI/FS Work Plan presented maximum values measured in ground water samples collected during baseline characterization. Disregarding Burro Canyon well 92-10 which was completed with steel surface casing extending down into the ground water; the arithmetic mean of iron concentrations in the Burro Canyon aquifer are 161 μg/L upgradient, 214 μg/L at the millsite, and 456 μg/L downgradient, with standard deviations of 151 μg/L, 292 μg/L, and 286 μg/L, respectively. Considering that iron is a common ion, that facies changes can significantly impact the concentration of iron measured in water, and that iron readily exists in the colloidal size fraction (higher iron concentrations anticipated in turbid samples), the differences in mean iron concentrations do not appear to be significant. If the differences in iron concentrations are real (i.e., significant), vertical leakage from the overlying units may be indicated.

Comment 30

<u>Section 4.5.2.1, Preliminary Toxicity Assessment, page 4-18.</u> It is unclear how toxicity benchmark values were derived from the literature, in particular how and when uncertainty factors were applied in the event that NOAEL's and LOAEL's from chronic studies were not available for each contaminant and each specific receptor of concern. The usual procedure is to <u>not apply</u> uncertainty factors <u>only</u> when you have a <u>NOAEL</u> from a chronic study in the <u>species of concern,</u> since the goal is to find the dose which is not expected to cause adverse effects to the health of the receptor. In this section it appears that uncertainty factors are not used to adjust toxicity benchmarks if the literature value is a LOAEL from a chronic, non-lethal study, or an LD50 or LC50. Non-lethal effects can have adverse impacts on populations if they alter fitness, so the LOAEL is not necessarily a "safe" exposure dose, and LD/LC50 concentrations are certainly not "safe". This approach should be clarified.

In addition, no mention is made of the use of uncertainty factors for intertaxon extrapolation when toxicity data were not available in the species of concern. Differences in xenobiotic metabolism, absorption and excretion between taxa can significantly affect sensitivity, but this issue was not addressed.

Response

a. *Clarification has been provided for the derivation of toxicity benchmark values for the preliminary ecological risk assessment. The preliminary risk assessment was used only to screen potential COCs and receptors. The methods used in this screening were not changed. In accordance with this comment, DOE has changed the approach for deriving toxicity benchmark values for risk characterization.*

b. *The Risk Characterization section of the revised work plan includes a detailed explanation of DOE's approach, including the uncertainty factors that will be used to adjust the toxicity*

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benchmark values. Uncertainty factors were used whenever a NOAEL from a chronic study in the species of concern was not available. Uncertainty factors were included for intertaxon extrapolation.

Comment 31

Section 4.5.2.1, Preliminary Toxicity Assessment, page 4-18, 19. Please be consistent in the use of abbreviations. Abbreviations follow the first use of the term written out and then the abbreviation is used exclusively throughout the text.

Please identify if any of the compounds are teratogenic (chemicals that have the ability to cause deformities in the developing fetus) for human and ecological receptors.

The toxicologic terms of LOEAL, LDLo and LD_{50} should be used in the singular form and not plural. These terms are specific to one chemical compound, therefore, please do not use the abbreviations of LOAELs, LDLos and LD_{50}s.

Response

Par. 1 The work plan has been changed such that abbreviations are used consistently.

Par. 2 Teratogenic chemicals of potential concern have been identified in the ecotoxicity profiles in the Exposure Assessment section of the risk assessment, but not in the Preliminary Toxicity Assessment. The Preliminary Toxicity Assessment will not be changed because it was only used to screen potential COCs and receptors.

Par. 3 The work plan has been changed such that the terms LOAEL, NOAEL, LDLo, and LD_{50} are used only in the singular form.

Comment 32

Section 4.5.2.1, Preliminary Toxicity Assessment, Ecotoxicity Profiles, page 4-20. Please expound on the toxicity of the COPC's. Due to the intent in this work plan to evaluate human and ecological risk to contaminants there should be substantial information for each COPC. Include in each profile information regarding its hazard potential and carcinogenic potential (this includes all COCs even the compounds that are radioactive). The toxicity associated with radiation is generally carcinogenic, and therefore, the toxicity can be discussed as combined radiation exposure. However, the hazard potential of the COC's are chemical specific. Secondly, there should be an effort to evaluate the toxicity to all receptors, especially those that have been identified as targets (humans, cattle and other ruminants, other mammals, waterfowl and other birds). Lastly, please properly reference the information.

The sentence "Barium is stimulatory but . . ." does not make sense. Please reword.

The sentence "Like cadmium, mercury is bioaccumulative . . ." is not accurate because the two metals bioaccumulate differently and do not have similar toxicities. Please reword.

Page 4-21. The sentence "Laboratory tests with brook trout and flathead minnows exposed to uranium were reported by Parkhurst et al." This sentence is an incomplete sentence. Please rewrite.

Response

Par. 1 Expanded ecotoxicity profiles have been added to the Exposure Assessment section of the ecological risk assessment. When possible, all ecological receptors of concern were addressed in these profiles.

Par. 2 The specified sentences have been reworded.

Comment 33

Section 4.5.2.1, Preliminary Toxicity Assessment, Ecotoxicity Profiles, page 4-21. The calculation of surface water criteria for terrestrial receptors is based on the assumption that 100% of the receptor's intake of a specific contaminant results from water ingestion. This is an unrealistic assumption for most receptors. Total exposure would be the sum of COC intake from water, food and soil. Assuming 100% of exposure from surface water may result in the derivation of water "criteria" which are too high, and therefore potentially not protective of terrestrial receptors. However, fish and benthic macro-invertebrates are expected to be more sensitive to most of the COPC's on this site than mammals or birds, so the risk in surface water will probably be driven by the aquatic receptors.

Response

The screening-level toxicity assessment was intended to help DOE refine the list of COPCs. The actual risk assessment addresses COPC intake from water, food, and soil (see the exposure assessment section of the ecological risk assessment).

Comment 34

Section 4.5.2.3, Preliminary Risk Characterization, page 4-23. It is acceptable as a first estimate to evaluate risk from exposure to one potentially contaminated media at a time; e.g., calculate HQ's based on intake from surface water alone, or on intake from soil ingestion alone. However, before conclusions can be made about the potential risk posed by specific contaminants to receptors of concern, total intake from all likely sources must be calculated and compared to properly derived toxicity reference values (benchmarks). Terrestrial wildlife will be exposed to contaminants through ingestion of vegetation or prey species in addition to ingestion of surface water and (not or) soil (or sediment in the case of aquatic mammals). Risks from all potentially contaminated media will be integrated by the receptors on the site, so all must be included in calculations of HQ's.

Response

The screening-level toxicity assessment was intended to help DOE refine the list of COPCs. The

actual risk assessment to be performed during the RI addresses COPC intake from water, food, and soil (see the exposure assessment section of the ecological risk assessment).

Comment 35

Section 4.5.2.1. Preliminary Toxicity Assessment. Abiotic Media Data. page 4-24. Concentrations of COPC's in surface water and soil/sediment are reportedly expressed as the mean and the "upper 95th percentile". EPA recommends the use of the 95% upper confidence limit of the mean sample concentrations (95%UCL) to estimate exposure. This value is not the same as the 95th percentile. Clarify which value has been used in this section.

Response

The text has been revised to clarify that the 95 percent upper confidence limit was used throughout the ecological risk assessment. In some cases, the maximum concentration was used in the Preliminary Site Calculations.

Comment 36

Section 4.5.2.3. Preliminary Risk Characterization. Surface Water and Soil Ingestion. pages 4-25 to 4-28. Wildlife benchmarks for radionuclides are being developed for use in the ERA for the Rocky Flats NPL site. EPA is currently reviewing the proposed process and results of this effort. Some of this information may be available from DOE to decrease uncertainty in the estimation of risk to ecological receptors at Monticello.

Response

If the Rocky Flats wildlife benchmarks for radionuclides are available and appropriate for ecological receptors in OU III, they will be used in the risk characterization portion of the ecological risk assessment during the RI.

Comment 37

Section 4.6.1.3. Release Mechanism. page 4-39. Under the first bullet in the last sentence, it should not be stated that the low-level residual contamination left in the soil after remediation is below health concerns. It is unknown whether or not the 5/15 pCi/g is a health concern. Please simply state that the low-level residual contamination will be below the 5/15 pCi/g standard.

Response

The text has been revised accordingly.

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Comment 38

Section 4.6.1.3. Release Mechanisms, page 4-39. Under the fourth bullet, the radon exposure to humans should not be estimated but, rather, measured. Please make this change to the text and plan to measure the radon levels emanating from the soil and sediments.

Response

The text and plan have been clarified accordingly

Comment 39

Section 4.6.2.1. Data Collection/Data Evaluation, page 4-42. The statement made under the third bullet of this section is not consistent with the State classification for Montezuma Creek. The State classification indicates that the creek may be used for domestic purposes after treatment. Please delete the part of the sentence which states that surface water is not intended or anticipated to be used as a drinking water source.

Response

This sentence was not modified because it was made in the context of the availability of potable groundwater and/or city supplied drinking water. However, a sentence was added about the State classification of Montezuma Creek.

Comment 40

Section 4.6.2.1. Data Collection/Data Evaluation, page 4-43. Please state under the second bullet of this page that ingestion of surface water is also a very important pathway for cattle, since this pathway is probably more important than the grazing.

Response

The text already states that ingestion of biota (by humans) could be an important pathway. A sentence was added noting that deer and cattle can be exposed from both grazing and ingestion of surface water. The significance of the surface water pathway relative to grazing has not yet been determined but will be assessed under the risk assessment.

Comment 41

Section 4.6.4.3. Assessment Program, page 4-58. Under "Sample Design", please include the collection of kidney tissue since it is very prone to metal uptake.

Response

Although kidneys are prone to metal uptake, it was not listed because cattle kidneys are very rarely ingested by humans in this country. Therefore, kidneys were not considered to be part of

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a complete pathway. The sampling protocol/modeling approach will be discussed at the August 17 meeting.

Comment 42

Section 4.6.4.3, Assessment Program, Sample Size Estimate on Means, page 4-59. In point #1, please include the consumption of surface water as a way for COPCs to be taken up by cattle as this pathway is probably the most important.

Response

See response to comment #40.

Comment 43

Section 4.6.4.3, Sample Size Estimate on Means, page 4-59. The assumption is made that all radioactive COC's can be related to Ra-226 which may be reasonable to evaluate the energy emitted for these compounds. However, it is inappropriate to assume that the hazards of these radioactive COC's are similar to Ra-226. Please provide estimates for sample size as it applies to all COC's.

Response

The sampling protocol/modeling approach will be discussed at the August 17 meeting.

Comment 44

Section 5.0, Feasibility Study, page 5-1. Please rewrite the first paragraph to be consistent with comment #2. The baseline risk assessment is one aspect in determining appropriate remedial actions. There are others such as regulatory compliance with ARARs.

Response

The referenced text has been deleted in the draft final Work Plan.

Comment 45

Section 5.3.2, Cost Screening, page 5-7. In the first paragraph, please delete "Geotech's experience. . ." and insert "DOE's experience. . ." It is DOE who is responsible for this task.

Response

The text has been revised as requested.

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Comment 46

Appendix A, Table 4.6-3. Please provide information (formulas and references) on the formulation of these human health screening benchmarks.

Response

This summary table was based on information presented elsewhere in the Work Plan. The groundwater and surface water screening benchmarks are the lowest (most conservative) values that are applicable from either State or Federal regulations. The soil and sediment values were calculated using standard default exposure parameters recommended by the U.S. EPA or taken directly from the EPA Region 3 Risk Based Concentration Tables from the fourth quarter 1994. More information to support the values presented in Table 4.6-3 (the summary table) is presented in Tables 4.6-4 to 4.6-6. Additional detail will be provided in the RI report.

Comment 47

Appendix A, Table 4.6-4. Please separate the COC's into distinct categories of cancer and hazard risks. Please include COC's in the two tables that are indicated to have both cancer and hazard effects. Please include in the legend what information is represented by the shaded cells.

Response

The COPCs in this table were not separated into distinct categories because this table is designed to show overall impacts. For COPCs that have both cancer and hazard efforts, only the worst case (or risk driver) was listed. In the actual risk assessment included in the RI, carcinogenic and systemic information will be listed separately. The legend does include what is represented by the shaded cells (see Footnote No. 1). This footnote states that "Shaded values indicate an exceedance of at least one regulatory or risk-based benchmark."

Comment 48

Appendix A, Table 4.6-17. Please include the kidney and bone samples in the analysis of animal tissue. The assumption to analyze animal tissue (muscle and liver) to represent the human consumption of the cattle or deer may be appropriate for that particular exposure scenario. However, this work plan focuses on ecological and human health scenarios. Therefore, to evaluate the ecological health of deer and cattle it is important to study metal content in kidney and bone as well as the intended biota. It is clearly stated in the text of the work plan (page 4-21) that not only does uranium have carcinogenic potential due to the radioactivity but it is toxic to the kidney and concentrates in the bone. Consequently, it is imperative to include these biota in the sampling plan to fully evaluate the body burden of the COC's.

Response

This will need to be discussed at the August 17 meeting.

Comment 49

Section 4.6.4.3, Assessment Program, pages 4-57 to 4-61. Where does DOE stand on the cattle exposure project to estimate risk to human consumers and as a surrogate for wild ruminants? The study as proposed in this section differs from the design outlined by EPA during our recent teleconference, and needs to be discussed. EPA and UDEQ maintain that if any contaminated materials are to be left in the canyon, in the absence of institutional controls which will probably require DOE or other Federal Agency to own the land, that the only acceptable risk assessment will require the cattle study.

Response

This will need to be discussed at the August 17 meeting.

Comment 50

Section 4.5.3.1 - Conceptual Site Model, 1st paragraph, page 4-29. ". . . hydrogeological reconnaissance efforts . . . that were conducted to support the ground water model did not reveal ground-water seeps of sufficient continuous flow within the OU III study area to form complete exposure pathways for OU III ecological receptors."

Review of Section 2.2.1 does not include information or studies that would exclude the ingestion of ground water for ecological receptors. On the contrary, a number of seeps have been observed in the lower canyon. Origins of the seeps were not explored because of time limitations. The seeps may be significant as a boundary condition in the upper flow system, or may have been a temporary condition. If continuous during low flow conditions, they may complete exposure pathways for ecological receptors.

Response

The text has been revised to clarify that if seeps that are large enough to provide drinking water for wildlife are found within Montezuma Canyon, the seeps will be sampled and the ground water ingestion exposure pathway will be included in the ecological risk assessment.

Comment 51

Section 4.6.2.1 Data Collection Data Validation, Bullet 1, page 4-43. "The Burro Canyon aquifer could be used as a source of drinking water. It is currently not contaminated but may become contaminated in the future . . . Ground-water modeling to determine future contaminant exposure-point concentrations in the Burro Canyon aquifer is necessary."

EPA concurs that studies to date have not identified any contamination in the Burro Canyon aquifer. A purpose of the modeling effort should be to include an analysis of vertical leakage term in the calibration process. Vertical discretization in the flow model is required to simulate vertical migration of contaminants. For example, only one layer may be used to model the Dakota unit, but for simulation of contaminant transport, this layer may need to be discretized into more than

one layer (C. Zheng, personal communication, February 1995). We would not recommend this level of vertical discretization for the initial attempt at ground-water flow and transport modeling, but concur that further along in the analysis, it may be necessary. (Please note: C. Zheng's name was consistently spelled incorrectly in the text and references.)

Response

[The following response is subject to change pending upcoming modeling discussions]

Vertical leakage will be assessed as part of the modeling effort. Initially, vertical leakage will be determined on the basis of existing hydraulic conductivity values. Vertical leakage will be refined through model calibration.

Comment 52

Section 4.6.4.1 - Data Quality Objectives, page 4-54. "Data use objectives for solute transport modeling are identified in Table 4.6-8 . . ."

Table 4.6-8 is titled "Preliminary Risk and Effective Dose Equivalent Estimates from the Historical Air measurements." Table 4.6-9 is titled "Summary of Data Quality Objective for the Upper Ground-Water Flow System Investigation - Human Health Risk Assessment" which is probably the table being referred to. However, in Table 4.6-9 there is a reference to Table 4.7-7, but there is no such table in this document. In addition, a table of this sort (Table 4.6-9) should be done for the Burro Canyon aquifer. The possibility of migration of contaminants to the Burro Canyon aquifer is a serious concern and needs to be explored.

Response

The reference to Table 4.6-8 will be changed to Table 4.6-9. Reference to Table 4.7-7 in Table 4.6-9 will be deleted. It is agreed that the possibility of migration of contaminants to the Burro Canyon is critical and needs to be explored. Existing analytical data indicate that the Burro Canyon Aquifer is currently not contaminated. Future water quality in the Burro Canyon Aquifer will be assessed through continued monitoring in conjunction with the OU III Annual Monitoring Program and subsequent long-term monitoring.

Comment 53

Section 4.7 - Task 6: Ground-Water Modeling, pages 4-62 to 4-100 General Comment. Although the overall approach to the ground-water modeling effort is reasonable, some aspects of the modeling approach should be reconsidered or abandoned. Some time-saving suggestions are offered for the ground-water modeling and should be considered. MODFLOWP is mentioned to demonstrate how model uncertainty and uncertainty of parameter estimates can be quantified.

Response

No response required.

Comment 54

Section 4.7, page 4-63. "HYDRUS model results will provide source term input to the MT3D code."

DOE needs to be more specific as to the use of the HYDRUS model and how the results will be utilized. The question to be answered for this part of the project is essentially, "What are the worse possible conditions that may exist in the unsaturated zone below the waste piles for the highest possible concentration of contaminants to enter the ground-water flow system?".

This task should be simplified so that the most conservative conditions should be simulated. Saturated hydraulic conductivity should be used, including the highest value of saturated hydraulic conductivity estimated, even though this is an unsaturated flow model. Using saturated hydraulic conductivity provides for a worse-case scenario. This assessment is not unreasonable because the zone between the waste piles and the ground-water flow system may at times be saturated. A unit gradient is commonly used in these analyses because this is also the most conservative estimate. In some cases, an analytical solution will be adequate. The resulting possible range of source term concentration that is estimated from this analysis should be considered as a starting point. **DO NOT estimate one value for a source term concentration and assume that value is correct.** Source term concentration is the single most sensitive parameter in a contaminant transport model and is commonly changed as part of the contaminant transport model calibration.

Response

The DOE plans to conduct conservative simulations for the HYDRUS (unsaturated) modeling. Conservative simulations will be conducted because 1) these simulations will allow an assessment of contaminant transport under the worst possible conditions, and 2) the lack of data in some areas forces a conservative approach. A purely conservative approach is not recommended. It is important that more realistic (less conservative) simulations be conducted to evaluate the range of outcome. A conservative approach using a saturated hydraulic conductivity (and possibly a hydraulic gradient of 1) would essentially negate the use of the HYDRUS model, and an analytical solution would be all that is needed. In addition, it was not intended to use one value for source term concentration; a range of source term concentrations will be used in the model.

Comment 55

Section 4.7-1 - Data Quality Objectives, secondary objective (3) p. 4-63. " . . . support or potentially confirm the validity of the hydrogeologic conceptual site model and, if necessary, refine the model."

The modeler should not get "locked into" only one conceptual model. The modeler may be more confident about some features of the conceptual model and may have greater uncertainty about other aspects of the conceptual model. The numerical model calibration can be used to assist the modeler with refining or even redefining the conceptual model.

Response

DOE will not get "locked into" a single conceptual model. Rather, the modeling conducted to date, especially work in model calibration, has indicated that alternate conceptual models or modifications to the main conceptual model are needed.

Comment 56

Section 4.7-1 - Data Quality Objectives, secondary objective (3) p. 4-64. "Another factor of the DQO process considered was the uncertainty associated with model results. Model uncertainty is very difficult to quantify because modeling results are dependent on complex interactions among numerous estimated variables."

Model uncertainty can now be quantified using MODFLOWP. DOE may want to consider using this program after a deterministic calibration to assess model uncertainty. MODFLOWP quantifies uncertainty of model results and quantifies the correlation between model parameters. If model parameters are highly correlated, then the model is predicting the ratio of the two parameters. For example, if hydraulic conductivity and recharge are highly correlated (correlation greater than .9), then the parameter values used in the model are merely the ratio of one parameter to another. Recharge may be estimated in the calibrated model at .01 cm/day and hydraulic conductivity may be estimated at 10 cm/day. But all that is truly known is that hydraulic conductivity is 1000 times greater than recharge, and the true value of hydraulic conductivity and recharge are unknown. Unless additional observation and data are added that will reduce this correlation, the true values are difficult to estimate. However, a high correlation between parameters does not discount model results if the model performance is similar to field observations.

Response

The use of MODFLOWP was discussed with the EPA early in the model planning stage. It was felt by both the DOE and EPA that because the learning curve for MODFOWP was significant and the modeling schedule was compressed, it was not the best course of action. Although using MODFLOWP has certain benefits, it will not be possible to meet the modeling schedule if the project switches to using MODFLOWP at this time.

Comment 57

Section 4.7-1 - Data Quality Objectives, secondary objective (3) p. 4-64. "It is generally presumed that model uncertainty can be minimized by increasing model complexity (refinement in the discretization of space and time)."

Research by a number of people (for example, see research papers by S. P. Neuman, S. Yakowitz, W. Yeh, J. Carrerra) generally state that as model complexity is increased, sum-of-squares error in the model may decrease, but confidence in parameter estimate increases. This is because there are a limited number of observations available (e.g., observations of seepage rates to and from streams and head in wells). Where more parameters are estimated than observations available,

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confidence in those parameters decreases. Therefore, a major part of ground-water modeling involves trying to estimate a reasonable zonation of parameters, and optimizing the number of zones in a model. Recommended practice is to begin with a homogeneous case, and add complexity.

Response

The DOE agrees that the ground-water modeling approach should begin with simple simulations and add complexity as the modeling progresses. It was not the intention of the referred to statement to imply that the ground-water model was to be made complex at the beginning. The model will gradually become more complex, both to achieve the physical attributes of the conceptual model(s) and as a result of calibration efforts, and to reflect incorporation of data from new wells.

Comment 58

Section 4.7.3.1 - Surface-Water Flow, page 4-67. " . . . it (recharge) is estimated that from .25 in/yr . . . to 1.5 in/yr . . . infiltrates the alluvial soils as recharge."

An earlier comment addresses these recharge figures. Fluctuations observed in the shallow ground-water wells would indicate that the low estimate of recharge may not be reasonable. How is the rapid fluctuation of water levels in shallow wells explained with a low recharge rate of .25 in/yr?

Response

The DOE would like to discuss further the relationship between precipitation and "rapid fluctuation of water levels in shallow wells". Specifically, what wells and precipitation dates and measurements are the EPA referring to, and what document was this data extracted from. Also see response to Comment 20.

Comment 59

Section 4.7.3.1 - Surface-Water Flow, page 4-67. " . . . 30 to 40 in/yr of irrigation water is applied to private and public lawns in the town of Monticello."

Is the above estimate of irrigation water defensible, initially it appears that this number is high. However, if these areas are included in the model, a net recharge should be estimated. If these areas are outside the model domain, then they should not affect the model.

Response

Most of the town of Monticello, Utah is included in the model domain. The estimate of 30 to 40 in/yr of irrigation water applied to private and public lawns in Monticello is based on information and an estimate provided by the Natural Resource Conservation Service (NRCS) in Monticello (see reference to Andrews 1994). The NRCS quoted an ET rate of over 40 in/yr (see

Section 4.7.3.1) for the town of Monticello. Numerous attempts were made to contact the scientist responsible for arriving at these figures with no success. To date, no additional information has been obtained, but attempts will continue. Estimated crop ET rates for the Monticello area (also provided by the NRCS) were of the same magnitude (30 to 40 in/yr) and the recommended annual irrigation amount for hay crops is 30 in/yr. At least one rancher in the millsite area applies the amount of irrigation recommended by the NCRS. Further inquiries will be made to obtain more exact irrigation schedules, if possible.

Comment 60

Section 4.7.3.1 - Surface-Water Flow, page 4-67. "ET in the Monticello area is estimated to be 42.8 in/yr."

Considering precipitation is only 15 inches per year, it would appear that this is a potential ET rate? Does this ET rate pertain to irrigated areas? Generally, we believe that ET is adding an unknown parameter and may unnecessarily complicate the model. Limit the number of unknowns in the model by using a net recharge rate. Estimating a true ET rate is difficult. In addition, you need to ask if this parameter is really as important as you think it may be. For example, during the spring, there commonly is snowmelt and higher water levels. Temperatures are still not high and plants and trees are just beginning to emerge from winter dormancy. Therefore, even though ground-water levels may be higher, evapotranspiration may not be significant especially where averaging yearly conditions. During summer months, temperatures have increased but water levels decrease. Even with increased temperatures, ET may not be as high as expected (except perhaps in areas near streams and surface water bodies) because ground-water levels are lower. Also, because of the uncertainty associated with the estimate of an ET rate, a net recharge rate is commonly sufficient to use. In some cases, recharge can even be input as a negative value if the modeler assumes that a sufficient amount of ET is occurring that may be depleting water levels in some places. Therefore, you need to estimate only the one parameter, net recharge. If you wish to use ET, do not add that parameter to the model until after the model is at least able to meet a convergence criteria without cells going dry because of artificial oscillations and there is less than 1% error in the water budget. This is because the ET rate is calculated for each iteration and the rate changes depending on the water level in the grid cell.

Response

See response to comment #59. Estimating both ET and recharge may unnecessarily complicate the model. It was and is the intention to use a net recharge rate, especially in the early stages of modeling. ET rates were discussed in the Work Plan for two reasons: 1) it is important to understand all aspects of the hydrologic cycle in the project area when formulating the conceptual model(s), and 2) a commitment to not using ET in the latter stages of modeling may be premature.

Comment 61

Section 4.7.3.1 - Surface-Water Flow, page 4-69. "The conceptual model assumes that any leakage from the waste water treatment lagoons is negligible and is not a major source to ground water in the area."

DOE needs to reconsider whether these (unlined?) lagoons situated on the Dakota Sandstone or Burro Canyon formation (?) may act as a specific point of recharge. If this is true, DOE needs to determine the local boundary conditions? A figure showing important features such as springs, seeps, lagoons, ponds, location of beaver ponds, areas of irrigation or lawn watering, etc. would have been useful in this section. Seeps and springs are commonly modeled as drains because they do not discharge unless the ground-water level is higher than the spring or seep elevation.

Response

The City of Monticello's waste water treatment lagoons have been and remain to be a concern regarding the ground-water model. A number of reasons led to the initial simplification that these lagoons have negligible leakage and are not a significant impact to the model: 1) observed seepage from these lagoons appears small and sporadic -- seepage forming puddles on a nearby dirt road and "wet" areas have been identified, 2) North Creek Diversion, the main drainage which is located immediately to the east of the facility, is dry much of the year and does not appear to be capturing significant (visible) lagoon leakage as might be expected, 3) stream-flow measurements in Montezuma Creek, south of the facility, do not conclusively indicate that leakage is contributing to flows (some increase in flows is probably from discharge of the alluvial aquifer and Burro Canyon aquifer, and 4) because there are no wells near the facility the true impact of leakage on the ground-water system(s) cannot be evaluated. Because of these observations, assigning a model boundary condition (or internal condition) to the lagoons does not appear appropriate at this time. However, a water balance for the lagoons will be conducted and should provide insight as to the magnitude of potential leakage and therefore the appropriateness of internal boundary conditions.

See Figure 3-3 for locations of seeps and springs. At least one other seep/spring, the Cabin Seep, has been located since Figure 3-3 was constructed. The "Cabin Seep" is located at the old cabin on the Montezuma Creek flood plain south of the mouth of North Creek tributary. Modeling of seeps and springs, especially those that appear to be active year around, will be attempted. Because the smallest cell dimensions expected in the model will be 50 by 100 ft and because seep and spring flows are very small, the ability to accurately model these discharge points is expected to be difficult, possibly leading to further inaccuracies. Similarly, the relative small size of the beaver bonds on Montezuma Creek warrant simplification of the model. The current approach is to treat these ponds as part of the stream using an average estimate of pond depth (stream stage and stream bottom elevations) as input into the river package of MODFLOW.

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Comment 62

Section 4.7.3.2 Ground-Water Flow, page 4-70-, 2nd paragraph. "... recharge is difficult to estimate and has been approximated."

ET (see comment --) is also difficult to estimate, so having a single unknown, recharge, is a more reasonable approach. If you include both recharge and ET, you are increasing the uncertainty of these two parameters estimates.

Response

This comment has been addressed under response to comment #60.

Comment 63

Section 4.7.3.2 Ground-Water Flow, page 4-70, 4th paragraph. "... distinct geochemical signatures and relative age differences between ground water of the Dakota and Sandstone and the Burro Canyon Aquifer also support the concept of limited hydraulic communication between these units ..."

Uncertainty in the age differences of the waters has been discussed previously. Geochemical differences would be expected for water moving through the Burro Canyon versus water moving through the Dakota. EPA does not believe that the studies conducted and information provided to date gives conclusive evidence to support the "concept of limited hydraulic communication between these units." Model calibration should include assessing the vertical leakage component in the model between layers. Also, increased iron levels in the Burro Canyon downgradient of the millsite should be considered a possible indicator of significant vertical leakage and possible contamination to that unit resulting from vertical leakage through hydrogeologic units above.

Response

DEPENDS ON MODELING APPROACH
The DOE believes the studies undertaken to date support the "concept of limited hydraulic communication between these units [the Dakota Sandstone and Burro Canyon aquifer]". Limited hydraulic communication means just that. Some hydraulic communication between the Dakota Sandstone and Burro Canyon undoubtedly occurs. That fact that the Burro Canyon aquifer does not have confirmed ground-water contamination is evidence to support the concept of limited communication. The DOE agrees that the observed increase in iron concentrations between up- and downgradient Burro Canyon aquifer wells could indicate that leakage (contaminant transport) is occurring from the upper flow system to the Burro Canyon aquifer. However, the iron concentration data for any particular Burro Canyon well varies considerably; this variation could be related to the turbidity in the samples collected from these wells. In addition, iron is not considered a conservative tracer, and any ground-water system may have numerous sources and sinks for iron; local facies changes, for example.

Finally, in contrast, chloride ion (considered a conservative tracer) concentrations for any one

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well in the *upper flow system or Burro Canyon aquifer are relatively constant compared to iron. Chloride concentrations are approximately one order of magnitude greater in the upper flow system than in the Burro Canyon aquifer. Also, chloride concentrations in both the upper flow system and Burro Canyon aquifer increase downgradient, a common characteristic in ground-water systems. The fact that at any one well, chloride concentrations exhibit relatively stable values and iron concentrations vary supports the possibility that iron concentrations may be effected by sample turbidity.*

Comment 64

Section 4.7.5.2 - Model Selection, page 4-77. "The finite difference equations can be solved using the Strongly Implicit Procedure (SIP) or Slice-Successive Overrelaxation . . . ."

The PCG-2 solver is also available. Different solvers may produce different results. For refined grids, for some models, SSOR or PCG-2 provide for more stable numerical solutions than SIP.

Response

The information on different solvers is noted and will be investigated during the modeling task.

Comment 65

Section 4.7.6.1 Development of Unsaturated Flow Model, page 4-81. "Because MODFLOW is not specifically designed to model extensive unsaturated conditions, the planned approach is to model the variable saturated portions of the Dakota Sandstone as vertical conductance terms to be applied to the bottom of the overlying upper flow system."

MODFLOW does not include unsaturated flow. However, portions of a saturated aquifer that are unsaturated are accounted for in the BCF2FM subroutine by adding a correction term (see for example comment C7D in this subroutine for where the mathematical correction is made for this condition). The true top of the unit should be entered into the program so that confined conditions are not simulated where the aquifer is actually unconfined.

Response

DEPENDS ON MODELING APPROACH
The paper "A Method of Converting No-Flow Cells To Variable-Head Cells For The U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model" (McDonald and others) has been partially reviewed. The remaining portions of the paper, including the section on the subroutine BCF2FM will be read and the applicability of the correction term will be evaluated and used if applicable.

Comment 66

Section 4.7.6.2 - Development of Saturated Flow Model, page 4-83. "Stream discharge information will be used to characterize flow magnitude and fluctuation in the upper Montezuma Canyon . . . ."

These are general comments about simulating Montezuma Creek. The ground-water model is simulating only that portion of surface water flow that either seeps into or out of the ground-water flow system. Therefore, the desire is to estimate ground-water seepage and calibrate to that flow amount. Part of the surface flow is from external sources and not from ground-water gains or losses. Gain-loss studies are indicators of how much a ground-water flow system is gaining or losing for a stretch of river. This gain/loss is the calibration target and is commonly difficult to estimate. However, estimating that value to within an order of magnitude (and sometimes within a half an order of magnitude) is not unattainable and is useful in the modeling effort.

Beaver dams should be modeled as general-head boundaries because they create a boundary condition along the creek and there is no hydraulic separation between the ground-water system and the ponds. These can be used in the calibration because the beaver dams are creating a condition where the surface water is seeping into the ground-water system and the ground-water system should be gaining in these reaches.

River conductance, KWL/m (hydraulic conductivity of river bed material times width of the river times length of the river divided by river bed thickness) is an unknown parameter, but river reach length, L, can be measured accurately. Therefore, estimate KW/m during calibration. Do not attempt to estimate the individual parameter. That will just waste time and won't add any useful information to the model.

Response

Par. 1 No response required.

Par. 2 The referred to sentence is general. Its purpose was to indicate the main use of stream discharge data. Characterization of stream behavior in space and time is vital to formulating site conceptual model(s) and a numerical model. The statement was not intended to imply that stream flows would be simulated.

The DOE is aware of the difficulties in flow calibration, especially in cases where overall flows may be small. All applicable and available data will be used to estimate the gain/loss components for any particular stream reach. The resulting estimated ground-water seepage calibration target will hopefully be within an order of magnitude or less of what can be achieved numerically.

Par. 3 Regarding the modeling of the relatively small beaver dams on the MMTS, please see last paragraph in response to comment 61.

Par. 4 The DOE agrees that the river conductance is difficult to calculate and that it will largely be assigned values as a result of model calibration. Individual parameters were estimated for the initial simulations.

Comment 67

Section 4.7.6.2 - Development of Saturated Flow Model, page 4-84. "The application of BRANCH and MODBRANCH will be investigated."

These models will not add any additional useful information to the model. The original river package will be sufficient for the purposes of this study.

Response

The DOE agrees with this statement - "The original river package will be sufficient for the purposes of this study." BRANCH and MODBRANCH will not be used. The sentence referring to these models was omitted from the Work Plan.

Comment 68

Section 4.7.6.2 - Development of Saturated Flow Model, page 4-84. "These boundary locations were selected because they provide physical justifications for specifying head and flux conditions."

Wherever possible, use a specified head boundary condition. Specifying a flux includes a larger degree of uncertainty because the head can be better estimated in most instances.

Response

Using a specified head boundary condition is more desirable because head data is either known or more easily estimated than a flux. Specified head data is preferable and will probably be used (in lieu of flux) in the final model. Specified flux may be examined in the sensitivity analysis portion of the modeling.

Comment 69

Section 4.7.6.2 - Development of Saturated Flow Model, page 4-85. "The dynamic average steady-state condition will be established by using an average annual recharge and calibrating to average annual heads."

Average steady-state conditions implies averaging water levels in wells. Therefore, an average and standard deviation can be calculated and used during calibration. For example, there is no reason to calibrate closer than a standard deviation, because there is at least that much uncertainty in the estimate of average annual head in the well. Also, be sure to decluster data if there are water levels taken more frequently during certain times of the year. For example, if there are a greater number of summer season water levels, the average estimate will be biased towards summer water levels. Finally, certain wells may provide better information than other wells for

calibration purposes. Where wells do not fall in the center of grid cells (hardly ever), triangulation should be done using surrounding grid cells to estimate the water level at the actual well location.

Response

The calibration of average annual heads should incorporate the use of the average head and standard deviation for each calibration well. This approach may shorten the overall head calibration task. The calculation of the average annual head data has and will take into account clustered data. To further refine head calibration, triangulation will be used between cells to arrive at a potential better estimate of head for a well not centered in the cell (most, if not all wells). The triangulation method will be used on a few wells at first and then evaluated prior to being used on remaining wells in the main area of flow and transport (Montezuma Creek Canyon).

Comment 70

Section 4.7.6.2 - Development of Saturated Flow Model, page 4-87. "Conductivity data will be used in MODFLOW to calculate a VCONT term for the variably saturated Mancos and upper and middle Dakota Sandstone and assigned to layer 2."

Calculate a VCONT as though these were saturated and MODFLOW will account for the unsaturated portion. This VCONT should be assigned to layer 1, not layer 2.

Response

DEPENDS ON MODELING APPROACH
The hydraulic conductivity values used in assessing Vcont are primarily from packer tests. Packer test conductivities, although generally used as horizontal conductivities in a small scale problem (say, in evaluating a volume of material of the order of several to tens of cubic feet), can be interpreted as representing both the horizontal and/or vertical conductivity value when the scale of the problem is large e.g. the modeling domain for OU III. Still, a common rule of thumb is to estimate the vertical conductivity as approximately one order of magnitude less than the "known" or estimated horizontal conductivity. In addition, it is of interest to maintain a conservative approach in making flow and transport calculations. For these reasons, the vertical conductivity, K_z needed for the Vcont calculation will be estimated over a range that is equal to the geometric mean of the results of the packer tests (conducted on the MMTS in 1993), plus or minus two orders of magnitude. For example, if the geometric mean of the Dakota Sandstone packer test hydraulic conductivity data is 10^{-7} cm/sec, the vertical conductivity will be approximated over a range of 10^{-9} to 10^{-5} cm/sec. This range will be used during head and flow calibration of the model and in the sensitivity analysis.

The application and adequacy of the correction term in the BCF2FM subroutine of MODFLOW to account for unsaturated flow and referred to in Comment 65, will be investigated.

The revised draft Work Plan incorrectly stated that the Vcont associated with the variably saturated Mancos Shale and upper and middle Dakota Sandstone would be assigned to Layer 2;

it will be assigned to Layer 1 (see paragraph 2 page 4-85). This change was made in the Work Plan.

Comment 71

Section 4.7.6.2 - Development of Saturated Flow Model, page 4-87. "At first approximation, geometric means of the pumping test and slug test hydraulic conductivity data will be used for the upper flow system."

A geometric mean biases the results to a low hydraulic conductivity value. This may not be reasonable for the flow and transport model. The higher values of hydraulic conductivity may be the more dominant component for flow and transport. A range of values should be considered during calibration.

Response

A range of hydraulic conductivities will be used in calibrating the flow and transport model. The geometric mean was suggested as an initial or first approximation (to initiate model simulations). See also response to comment #22.

Comment 72

Section 4.7.6.2 - Development of Saturated Flow Model, page 4-87. "Thickness of the Burro Canyon Formation is a quantity needed as input (layer thickness) . . ."

Transmissivity may be entered to account for the variable thickness, or the top and bottom of the formation can be entered as part of input. VMODFLOW may allow you to enter a layer thickness and then calculate a transmissivity, but input for MODFLOW does not include layer thickness.

Response

MODFLOW does not directly require the input of layer thickness. The statement was made with the intention of using the top and bottom elevations of the Burro Canyon Formation. The Work Plan was reworded to correct for any confusion caused by the original statement.

Comment 73

Section 4.7.6.2 - Development of Saturated Flow Model, page 4-88. " . . . bottom elevations for each layer will be assigned on a cell-by-call or zone basis using contoured lithologic contact data, otherwise an average bottom elevation will be assigned to each layer."

For some models, tilt of hydrogeologic units may be important. In some cases models that would not initially solve properly will work well after the tilt of the unit is included. This can be accomplished by varying the bottom elevation of the grid cell.

Response

Varying the bottom elevation was planned and has been used to some degree in current modeling efforts. Unfortunately, the current version of VMODFLOW, a MODFLOW pre-and post-processor, does not allow this option. Future versions of VMODFLOW will, and current versions of the Groundwater Modeling System (GMS) do allow variable bottom elevations. These versions are currently undergoing beta testing. If available, they will be used for the modeling efforts.

Comment 74

Section 4.7.7.1 - Initial Flow Simulations, page 4-88. ". . . alternate simplified conditions may be implemented until successful representative model simulation are attained."

This approach is putting the "cart before the horse." The best approach is to begin with the desired model grid, but maintain a simple model by including only one layer, a homogeneous system, and boundary conditions such as rivers, recharge (homogeneous), constant head. General parameter values can be estimated by examining the water budget. The goal is to get a model that will 1) run, 2) not have any cells go dry because of artificial oscillations in the solution, 3) converge, 4) have less than 1% water budget error, and 5) have an array of starting heads that are "solved" heads. Also, the overall water budget should be in the range of the estimated water budget. Ending heads from that simulation can be used for starting heads for subsequent simulations (only if no cells are going dry). When this goal is met, complexity can be added to the model, one complexity at a time, including adding additional layers, varying zonations, and so forth. Also, note that although Anderson and Woessner state in their book that model error is acceptable where general-head-boundaries are used to simulate constant heads, this idea is not widely accepted by the modeling community and the budget error must be less than 1% for steady-state simulations.

Response

The referenced statement was made in the case that the model won't meet the goals as stated in the comment. In other words, if the initial and perceived to be simple model would not even run and/or have a excessive dry cells, then perhaps the model wasn't simple enough to start with and further simplifications might be necessary. The DOE agrees with the initial goals described in the comment. The first paragraph under Section 4.7.7.1 attempted to state a similar approach by mentioning "bugs" and nonconvergence. The more explicit goals in the EPA's comment were incorporated in Section 4.7.7.1 to better state the concept behind conducting initial flow simulations. At this time, no general-head boundaries are anticipated in the model, thereby any mass balance errors associated with these type of boundaries should be avoided.

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Comment 75

Section 4.7.9 - Initial Transport Simulations, Calibration and Sensitivity Analysis, pages 4-96 through 4-100. General Comments

The modeler will be creating a steady-state ground-water flow model, but the transport portion of the model is transient for transport (even though the flow field is steady-state). Initially, the various source terms should be simulated to represent when the contaminant first entered the ground-water flow system, and let the system run from that time to the present observations. The objective for calibration is to match the concentration observations in the model with the concentration observations in the field. Calibration may be done for different contaminant constituents. The assumption is that initially no contaminant was present in the ground-water system. Therefore, other than the sources, there should not be any other areas of initial concentrations. When this calibration is achieved, future scenarios can be simulated for the plumes of concerned. The calibration portion of this task will produce a model representing current conditions. Future scenarios can include aquifer cleanup or running the model for an extended period of time to assess natural dissipation of the contaminant.

Source terms can be removed to simulate removal of the piles at the MMTS. However, because of the uncertainty associated with secondary sources of concentration, attempting to simulate secondary sources may not be a useful exercise. There will be so much uncertainty with predictions that the results may not be practical.

Sensitivity analysis is useful in assessing which parameters are the most sensitive in the model. The parameter is perturbed, and the change in head and flow is observed. Parameters that are insensitive will not produce much change in head, and they are therefore not particularly useful in assessing the ground-water flow system. This analysis may also be done for transport parameters to observe how concentrations change with change in parameter. In addition, change in concentration with change in flow parameters is also useful in assessing which flow parameter are more important in the model.

Response

The information presented in the first paragraph of this comment regarding the transport calibration procedure is the same view held by the DOE and is described in Section 4.7.9.2. Revisions to this section were 1) in the third paragraph, page 4-97, last sentence, ". . . in order of increasing importance, . . ." was omitted. Source term concentration is viewed as the most important parameter in the transport model, the impact of dispersivity, however, may also be significant. The sensitivity analysis will help confirm the relative impact of transport parameters on model outcome. 2) The sentence "The upgradient baseline concentrations of COPC's, although relatively small compared to millsite area concentrations, will be evaluated and may be input as initial upgradient source term concentrations." will be added.

There is an certain amount of uncertainty associated with "secondary" sources. Secondary sources include smaller, less significant sources of COPCs than the main tailings piles. Examples are stream deposited materials, wind deposited materials, and potential small areas

*used for fill near the millsite. The DOE concurs that the uncertainty involved with assigning
locations and concentrations of these sources is great, and modeling of such potential sources is
not planned.*

*Transport calibration will be conducted using a calibrated flow model. Once transport
calibration is complete, sensitivity analysis will focus on varying transport parameters. In
addition, basic flow parameters (hydraulic conductivity and recharge) will be varied to evaluate
the effect on transport concentrations.*

Comment 76

<u>5.0 Feasibility Study, page 5-1</u>. General Comment

We are concerned that the Section is more like a primer than it is a discussion of the generally
accepted practices and available remedies for remediation of contaminated sediments. Generally,
EPA and UDEQ believe that remediation alternatives that have been implemented at the
Monticello Vicinity Properties and Operable Units I and II of the Millsite encompass the range of
alternatives available to DOE. Further, we maintain that the excavation of contaminated material
can be expanded to include a number of feasible and tried alternatives (e.g., utilization of hot spot
cleanup criteria, environmentally sensitive cleanup).

Response

*DOE agrees that remediation alternatives implemented under OUs I and II encompass the range
of likely alternatives for remediation of contaminated soil/sediment under OU III. This has been
clarified in the draft final Work Plan.*

Comments on RI/FS Field Sampling Plan

Comment 77

<u>Section 3.1.3.1, Chemical and Histopathological Analysis, Avian Species, page 3-4</u>. DOE should
consider analysis of the swallow livers and kidneys for total radioactivity (split out total alpha,
beta and gamma activity) in addition to metals analysis, as discussed during our recent
teleconference. Additional tissue requirements would be minimal. Many of the radionuclides of
concern concentrate in the kidneys (and liver to a lesser extent), as well as the bone. If the cattle
exposure study is not conducted, and field surveys indicate insufficient numbers of beavers or
muskrats to sample aquatic mammals, no organ-specific uptake data for radionuclides will be
obtained on the site.

Response

*Cliff swallow liver samples were collected and analyzed for gross alpha, beta, and gamma
radioactivity and metals COCs. Because cliff swallow kidneys are very small (and therefore
large numbers of birds would have been killed in an effort to obtain a single kidney sample for
chemical analysis), kidneys were analyzed with the whole carcass samples.*

As agreed at the June 21, 1995, ETAG meeting, beaver and/or muskrat samples will not be collected unless DOE determines that, based on benthic macroinvertebrate data, it is necessary. The benthic macroinvertebrate studies outlined in the revised work plan were intended to allow DOE to adequately assess aquatic communities in OU III without beaver and/or muskrat sampling.

Comment 78

Section 3.1.3.2. Population Surveys. page 3-6. As DOE is probably aware, the proposed sampling efforts for passerines, raptors, small and large mammals conducted one time during a single season will not produce much useful information due to potentially large natural variability, and numerous non-contaminant-related impacts on populations and animal movement. Interpretation of results will be problematic, but they represent one more qualitative bit of information in the weight of evidence approach to making decisions regarding potential risks to the health of the environment at the site.

Response

Because population survey results are not expected to provide much useful data, the surveys have been eliminated from the work plan. However, surveys to allow DOE to determine the presence or absence of ROPCs (including the spotted bat, southwestern willow flycatcher, peregrine falcon, and fish) were conducted within OU III.

Comment 79

Section 5.1.2.1. Terrestrial Biota. page 5-3. "The dead nestling will be weighed and necropsied, and gross abnormalities noted."

We would suggest collecting nestlings from the reference site prior to sampling at the BSA. Unless the field crew is very experienced in avian pathology, they will need to examine several normal nestlings to become familiar with relative size, texture and color of internal organs and tissues before they would be able to discern subtle abnormalities.

Response

DOE attempted to sample the reference area cliff swallows before the Montezuma Creek cliff swallows. However, because the reference area swallows nested approximately three weeks after the Montezuma Creek swallows, it was necessary to sample the Montezuma Creek swallows first. Gross abnormalities were not found in birds from either location.

Comment 80

Section 5.1.2.1. Terrestrial Biota. page 5-4. "... *Peromyscus* sp. are not being accepted by analytical laboratories ..."

EPA does not believe that this statement is strictly true. There are labs that will handle field mice

from endemic Hantavirus areas and we can pass this information on to DOE if it becomes necessary.

Response

During the June 21, 1995, meeting, the ETAG recommended that DOE eliminate the golden eagle as an ROPC. Instead, the ETAG recommended that the deer mouse be included as an ROPC. The ETAG suggested that DOE collect terrestrial invertebrates, terrestrial plants, surface water, and soil to support the risk assessment for the deer mouse. DOE did not collect deer mouse samples. Because of these changes in the risk assessment approach, based on the June 21, 1995, meeting, this comment no longer applies to the OU III ecological risk assessment.

Comment 81

Section 5.1.2.1, Terrestrial Biota, page 5-4. "It is presumed that one specimen will satisfy the lab-specified minimum sample mass requirement (up to 200 grams)."

True if it is a ground squirrel, but not if it is a vole.

Response

During the June 21, 1995, meeting, the ETAG recommended that DOE eliminate the golden eagle as an ROPC and eliminate the small mammal sampling that would have supported the assessment of risk to golden eagles. Because of this change in the risk assessment approach, this comment no longer applies to the OU III ecological risk assessment.

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Appendix F

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